104

TECHNOLOGY ADMINISTRATION/NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY FISCAL YEAR 1997 AUTHORIZATION

Y 4.SCI 2:104/41

Technology Administration/National...

HEARING

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE

U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTH CONGRESS

SECOND SESSION

APRIL 16, 1996

[No. 41]

Printed for the use of the Committee on Science

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*Ranking Minority Member
**Vice Chairman

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April 16, 1995:

Dr. Arati Prabhakar, Director, National Institute of Standards and Technology, Gaithersburg, Maryland, Accompanied by Gary Bachula, Deputy Under Secretary for the Technology Administration, Washington, DC 4

TECHNOLOGY ADMINISTRATION/NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY FISCAL YEAR 1997 AUTHORIZATION

TUESDAY, APRIL 16, 1996

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
SUBCOMMITTEE ON TECHNOLOGY,
Washington, DC.

The subcommittee met at 2:10 p.m. in Room 2325 of the Rayburn House Office Building, the Honorable Constance A. Morella, Chairwoman of the subcommittee, presiding.

Mrs. MORELLA. I am going to call the Technology Subcommittee meeting to order. We have a very brief meeting here today because it is important that we have this hearing.

The tragic death of Commerce Secretary Ron Brown has forced the postponement of today's previously scheduled Subcommittee field hearing at NIST and the ground-breaking ceremonies for the Advanced Chemical Sciences Laboratory. I certainly understand the difficulties in preparing and conducting these activities during this period of mourning.

I share the sympathies and grief for the late-Secretary's family and his staff and, as a matter of fact, as an aside I had the opportunity with the Human Rights Project Group to go to India last week and it was there that we heard about the demise of Ron Brown.

I had an opportunity with the business leaders to talk about what he had done in terms of last year having a very successful trip to India in opening up all kinds of avenues for business enterprises.

I certainly want to thank Dr. Arati Prabhakar, accompanied by Gary Bachula—did I pronounce it right?

Mr. BACHULA. "Bah-hoo-lah".

Mrs. MORELLA. Bachula, better stressed, for testifying before us today as the Subcommittee considers the President's Fiscal Year 1997 budget request.

Again, I reiterate, I appreciate your appearance during this difficult time.

The work which is conducted at NIST is vital to our Nation's competitiveness. I am certainly very proud of the work that is done at NIST by the scientists and commend Dr. Prabhakar for instilling a fresh vigor and a sense of excitement for the NIST mission among her staff.

As the Chair of this Subcommittee I am supportive of NIST and its programs. I will do what I can to create the best environment to fund them in the budget process.

I look forward to the testimony of Dr. Prabhakar, and I think this hearing should be helpful not just for use in this committee but as these issues are debated through the Budget Committee and the Appropriations Committee.

I would now like to yield to our Ranking Member of this Subcommittee, Mr. Tanner, for any opening statement he may make.

Mr. TANNER. Thank you, Madam Chairwoman.

I would like to welcome our witnesses from NIST and Dr. Prabhakar for coming over this afternoon. It has been a difficult last couple, three weeks, and I think all of us in reflection would conclude that the country suffered a great loss and a great leader.

I am glad that we are here today because this is quite likely going to be the only testimony we will hear on the Technology Administration before the Science Committee's Full Committee goes to authorization.

I have some questions about the procedure we will follow, but I will take those up with the Chair privately.

You know, I have gone on and on from time to time—and I have got a statement that I will submit for the record, with your permission, Madam Chairwoman—about how important these programs that we talk about in this Subcommittee are to the future of this country.

I think that sometimes NIST is a stealth agency. It does so much for the everyday lives of people in this country, and yet it does not receive, I think, near enough publicity, just the calibration and the standards that the medical labs use so we all know that if you are getting so much radiation for a cancer treatment, that is the kind of radiation you are given.

There are just countless hundreds and thousands of things that we take for granted that are done there that are absolutely vital to this Nation, and I wish we could have more time to talk about some of the programs.

I also am very concerned about the future of two external programs, ATP and the Manufacturing Extension Partnership program.

I have gone off about how important I think these are to the private industry and to leverage the monies available in the private sector for long term or blue sky research and development, and how these programs are working based on almost any objective measurement.

I am fearful that if these programs are destroyed, as some would want, that the future technology base of this country will be in great peril. I would argue that point with almost anyone on any objective basis.

So I thank the Chair for having this hearing. We look forward to the testimony and hopefully we can have a record that we can be proud of as we go forward in whatever way the Chairman of the Full Committee decides to proceed.

Thank you.

Mrs. MORELLA. Thank you, Mr. Tanner. Certainly there is no objection to whatever materials you want to include in the record being so included.

[The prepared statement of Mr. Tanner follows:]

PREPARED STATEMENT OF HON. JOHN S. TANNER (D-TN)

SUBCOMMITTEE ON TECHNOLOGY

COMMITTEE ON SCIENCE

TECHNOLOGY ADMINISTRATION/NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY: BUDGET REQUEST

APRIL 16, 1996

I want to join Chairwoman Morella in welcoming Dr. Prabhakar to this afternoon's hearing. Although I am sorry that Dr. Good could not be here today, I understand that as Acting Secretary for Commerce she has other duties to attend. I realize that this has been a difficult time, because of the death of Secretary Brown, to get testimony written and cleared. I want to thank you for your efforts to appear before the Committee today, because this is likely the only testimony we will hear on the Technology Administration before the Science Committee marks an authorization bill.

At last year's authorization hearing, I related a story about the beginnings of the National Institute of Standards and Technology. In the early years of this century there were no uniform pipe thread standards. As a result, the City of Baltimore burned to the ground because none of the surrounding fire departments could hook their hoses to Baltimore's fire hydrants. And so NIST was born.

In the past year I've learned a lot about NIST's programs. I now call it the stealth agency. Among all Federal agencies it is the least known and least understood, yet NIST activities directly affect the lives of Americans on a daily basis. NIST provides standards for electric meters that monitor electric consumption in our homes ($188 billion in 1992); it provides standards and calibration services to medical labs to ensure that cancer patients receive safe and effective treatment; it provides standards that measure the ability and accuracy of different computer systems to "talk" to each other which is vital for any financial transaction; and NIST develops new standards that support advances in high technology industry. To put it simply, how does one make something better?—an objective standard by which to measure is a necessity. The NIST laboratory program fills this vital role.

I also want to mention two other important activities of NIST—the Advanced Technology Program (ATP) and the Manufacturing Extension Partnership (MEP). In the current economic climate there is a need for government and industry to work together on high-risk, long-term technology development. I also believe that the Federal Government should work with state and local governments to help small and medium-sized businesses meet the challenges of international competition. The ATP and the MEP were designed to meet these goals. These two programs have some of the most stringent review and assessment procedures of any Federal program. And although these are two relatively new programs, early results indicate that they are working.

Although the MEP and the ATP represent less than 1% of Federal R&D investment they have been among the most criticized programs in this Congress. I hope that we can put aside the rhetoric and evaluate these two programs solely on their merits. In my opinion, if these programs are terminated, the future technology base of this country will be weakened.

I want to thank Chairwoman Morella for holding this hearing today and look forward to working with her on a TA/NIST authorization bill.

Mrs. MORELLA. I would like now to yield time to Ken Calvert, the Vice Chair of this Subcommittee, for any opening comments he may have.

Madam Chairwoman, I have no opening statement at this time. I look forward to the testimony.

Mrs. MORELLA. And we have been joined by Ms. McCarthy, if she would like to make any initial comments?

Ms. MCCARTHY. I apologize for being late. I do not have any comments at this time.

Mrs. MORELLA. Well, then, Dr. Prabhakar, I followed you yesterday at that Telemedicine Conference for just a little bit of the questioning and I thank you for being there. It ties in with the kind of thing you do.

STATEMENT OF DR. ARATI PRABHAKAR, DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, GAITHERSBURG, MARYLAND, ACCOMPANIED BY MR. GARY BACHULA, DEPUTY UNDERSECRETARY FOR THE TECHNOLOGY ADMINISTRATION, WASHINGTON, DC.

Dr. PRABHAKAR. Great.

Thank you very much, Madam Chairwoman, for both your comments and Mr. Tanner's. Thank you both for your support and your kind words about Secretary Brown. Each of us who worked with him was proud to have had that opportunity.

In addition to my written testimony which I would ask to submit for the record, I would also like to ask if I could submit a copy of our 1997 Budget Highlights.

Mrs. MORELLA. Without objection, that will be included.

[The following information was received for the record:]

'97 TECHNOLOGY ADMINISTRATION BUDGET HIGHLIGHTS

From biotechnology to telecommunications, technology underpins the fastest growing industries and high-wage jobs. Leading economists estimate that advances in technology account for at least half of our country's long-term economic growth since World War II. The Clinton Administration's economic policy recognizes the importance of technological innovation to U.S. competitiveness. President Clinton has articulated a clear role for government investment in civilian technology in partnership with industry and emphasizes the creation of a favorable business climate. Consistent with that policy, the Department of Commerce—with the Technology Administration (TA) at the lead—is implementing an industry-driven agenda to ensure American companies and workers have the tools needed to compete and win in the new global economy.

Led by the Under Secretary for Technology, the Technology Administration includes the Office of Technology Policy, the National Institute of Standards and Technology, and the National Technical Information Service. Together these components provide a focal point for the government's policies and programs that foster private-sector innovation, strengthen the nation's competitiveness, and raise the standard of living for all Americans. Specifically, the Technology Administration:

- partners with industry to develop new technologies with important commercial potential;
- helps deploy the new technologies and practices to American firms;
- enables an effective and efficient technological infrastructure for the 21st century; and
- provides the leadership in both public- and private-sector initiatives to strengthen U.S. industrial competitiveness.

To continue the successful implementation of this civilian technology agenda, the President requests:

Office of the Under Secretary/Office of Technology Policy:
Total funding requested: $9.5 million

National Institute of Standards and Technology:
Total funding requested: $826 million

National Technical Information Service
No funds requested; NTIS is a self-supporting agency.

Specific budget proposals are described on the following pages.

U.S. Department of Commerce
March 1996

US/OTP Budget Highlights

SUMMARY

President Clinton requests $9.5 million for the Office of the Under Secretary for Technology and the Office of Technology Policy (US/OTP) for FY 1997.

This request supports the most basic US/OTP core competencies and functions necessary to meet critical Administration and Congressional civilian technology priorities.

The funding will provide support for the Under Secretary as she oversees TA's three bureaus and coordinates and leads several interagency civilian technology efforts. It also maintains OTP's role as the executive branch's principal civilian technology policy analyst and advocate.

In addition to serving as the principal adviser to the Secretary and as the Department's spokesperson for science and technology issues, the Under Secretary chairs the National Science and Technology Council's Civilian Industrial Technology Committee, where she continues to be a voice for U.S. industry in government-wide technology initiatives like the Partnership for a New Generation of Vehicles (PNGV). The Under Secretary remains the principal U.S. government representative for technology on the U.S.-Japan Economic Framework Talks, the U.S.-Egypt Partnership for Economic Growth, the U.S.-Israel Science and Technology Commission, and the Presidential initiative to support the peace process in Northern Ireland.

The President's proposal also will enable US/OTP to:

- manage the government's participation in the PNGV;
- evaluate the technical capabilities, technologies, and policies of key U.S. trading partners;
- assess the impact of fiscal, tax, and regulatory policies on the U.S. climate for innovation;
- support international science and technology agreements, including the U.S.-Israel Science and Technology Commission; and
- improve cooperation and collaboration between federal science and technology efforts and state science and technology programs.

JUSTIFICATION

The Clinton Administration has a demonstrated understanding of the relationship between technology and our nation's long-term economic security. A recent study by the Commerce Department's Economics and Statistics Administration found that manufacturing firms using advanced technologies are more productive, pay higher wages, offer more secure jobs, and increase employment more rapidly than those that do not.

The Administration also has a clear understanding of the challenges our nation faces:

- Foreign competitors have demonstrated their ability to scour the world for leads and turn innovation into commercial success, often with

technological breakthroughs that occurred in the United States.

◆ Many U.S. firms, especially the 381,000 small and medium-sized manufacturers, have been slow to adopt new manufacturing technologies that can yield dramatic improvements in product quality, cost, and time-to-market.

The Administration has charged US/OTP with devising policies and strategies for facilitating technological development and deployment, promoting manufacturing competitiveness, and ensuring that U.S. industry has access to scientific and technical information throughout the world. The requested funding for FY 1997 will help ensure that US/OTP fulfills its role as a leader of the federal government's civilian technology efforts.

Despite its relatively small size, US/OTP has had a string of recent accomplishments that have had a significant impact on industrial competitiveness and economic growth:

◆ OTP has long played a leadership role in maximizing the value of federal mission research to the U.S. economy. US/OTP has just published *Effective Partnering: A Report to Congress on Federal Technology Partnerships*. This report analyzes the effectiveness of several mechanisms used by the federal government for partnering with industry in research and development. The report provides strong support for the concept of partnering to maximize the benefits of government research for the U.S. economy and offers recommendations for further improving the effectiveness of public-private partnerships.

◆ OTP's Meeting the Challenge initiative is providing industry with a unique forum for presenting its views to government. OTP has worked with the private sector to prepare competitive assessments of key industry sectors. This initiative has served as a catalyst to bring industry groups together to develop technology strategies and policy agendas. OTP, in partnership with the Chemical Manufacturers Association, recently published the first report in the series on the chemical industry. This report has been widely acclaimed by industry representatives and federal policy makers for its presentation of industry views on the opportunities and challenges facing the chemical industry as it prepares for the 21st century.

◆ OTP's advocacy on behalf of the U.S. pharmaceutical industry was instrumental in the National Institutes of Health's decision in April 1995 to drop the "reasonable pricing" clause from its cooperative research and development agreements. This provision was viewed by the pharmaceutical industry as a significant barrier to partnership with NIH.

◆ Under the auspices of the U.S.-Israel Commission, US/OTP has worked to harmonize the U.S. and Israeli systems that regulate devices, drugs, and biologics to the mutual benefit of both countries and the pharmaceutical and business interests in each country.

◆ OTP's advocacy also has helped alleviate restrictions on the export of pharmaceuticals and other medical products. These restrictions were encouraging U.S. companies to move their manufacturing and R&D operations overseas. In April 1995, the U.S. Food and Drug Administration announced its intention to work with Congress on legislation to allow the export of pharmaceuticals and medical devices to 21 industrialized countries without prior FDA approval.

PROGRAM DESCRIPTIONS

US/OTP's central mission is to evaluate and promote technology policies and initiatives that will strengthen U.S. industrial competitiveness. Increased funding in FY 1997 is requested to support critical programs, including the Partnership for a New Generation of Vehicles (PNGV), the State-Federal Cooperative Science and Technology initiative, and the U.S.-Israel Science and Technology External Grant Fund.

Partnership for a New Generation of Vehicles—$375,000. The automobile plays a central role in U.S. manufacturing and the economy as a whole. Automotive and allied industries employ 1.2 million people, or 6.5 percent of American manufacturing workers. If the U.S. auto industry is to remain competitive into the 21st century, it must aggressively adopt new product and process technologies. To help the industry remain competitive—contributing wealth and jobs to the nation's economy, to reduce the nation's dependency on petroleum-based fuels, and to cut air pollution, the government joined in a unique

partnership with more than 300 automotive manufacturers and suppliers. Since its inception, this ambitious technological partnership has made significant progress toward its goal of accelerating development of a production prototype vehicle, comparable to today's automobiles in safety, cost, and amenities, but three times as fuel efficient. A government-industry engineering team crafted a detailed strategic plan, outlined specific R&D goals for this historic endeavor, and started research on numerous technical projects.

FY 1997 is a pivotal year for PNGV: Screening of candidate technologies for the prototype fuel-efficient "Super-Car" must be completed by the end of 1997. The favored technologies then will be incorporated in the concept vehicles to be developed by car companies in the following years. In addition, the requested funds will permit acquisition of Rand/CTI Radius S&T inventory data for effective monitoring of federal research projects in multiple agencies that support the PNGV.

State-Federal Cooperative Science and Technology Initiative—$1 million. Funding is requested to support a new effort to extend the benefits of existing federal science and technology efforts through closer cooperation and collaboration with state science and technology programs. Economists estimate half of all economic growth since World War II can be attributed directly to technological innovation. However, the flow of new knowledge into competitive products, processes, and firms is not automatic; foreign competitors can appropriate the results of U.S. science as easily as American companies. If federal science and technology efforts, which focus on national needs and missions, can work more closely with state efforts focused on growing new businesses and jobs, the nation's economy can better capture the benefits of $70 billion in federal R&D investments.

Last year a State-Federal Technology Partnership Task Force, reporting to the President's Science Advisor, made four broad recommendations that were designed to (1) renew the national science and technology system, (2) build the role of the states in that system, (3) catalyze private-sector investments in technology, and (4) build national excellence in manufacturing. The foundation for these efforts requires new institutional links between federal and state governments because existing mechanisms are inadequate. The President's Science Advisor asked the Under Secretary for Technology to chair an interagency group to forge new working relationships with the states in science and technology and to re-examine federal programs to make them more collaborative with state efforts. The funding will:

- provide support for the interagency working group,
- enable studies of regional technology-based economic development strategies,
- create an updated database of state technology programs and information on their effectiveness, and
- initiate the necessary interactions with programs and leadership in the 50 state capitals.

U.S.-Israel Science and Technology External Grant Fund—$2.5 million. The President requests funding to increase collaborative activity between the high-tech sectors in the United States and Israel, that in turn will create high-wage and high-value jobs, expand our export opportunities—particularly in the Middle East, and strengthen both countries' economies. In FY 1997, funding is requested to facilitate joint ventures between U.S. and Israeli governments in technology-specific areas and to support working group activities focusing on new and novel technologies; impediments, infrastructure, and opportunities; and university/industry relations.

The program focuses on long-term, higher risk projects and, consequently, represents greater reward potential. The cooperative agreements are designed to leverage much larger funds contributed by the private-sector participants, funds from existing programs of both governments, and funds from the venture capital community.

NIST Budget Highlights

SUMMARY

The Administration's fiscal year (FY) 1997 budget request to Congress includes $826 million for the Technology Administration's National Institute of Standards and Technology (NIST).

The NIST FY 1997 budget request is divided into three appropriations:

◆ $450 million for extramural programs, including $345 million for the Advanced Technology Program (ATP) and $105 million for the Manufacturing Extension Partnership (MEP);

◆ $271 million for research by NIST laboratories and support for quality programs associated with the Malcolm Baldrige National Quality Award; and

◆ $105 million for construction of advanced research laboratory facilities and major renovations of NIST's existing facilities.

The Administration remains an enthusiastic supporter of NIST programs as critical catalysts for the nation's long-term economic growth. This budget represents the funding necessary to avoid losing hard-won momentum for the future economy gained through expansion of NIST programs in FY 1994 and 1995.

This funding is necessary to:

◆ allow the highly effective Advanced Technology Program to accelerate development of innovative but risky technologies with the potential for big payoffs in broad-based benefits to the nation's economy. The additional funding will continue support for all current ATP projects to which multi-year funding has already been committed and will allow funding of a general competition and additional focused competitions. The increase restores the program to approximately the level of its post-rescission FY 1995 appropriation.

◆ complete the Manufacturing Extension Partnership's expansion to a national network of locally operated and NIST co-funded extension centers providing hands-on technology and business assistance to the nation's 381,000 smaller manufacturers.

◆ bolster NIST's laboratory efforts in semiconductor metrology. The new funding will enable NIST to develop new measurement tools and services needed by the semiconductor device, equipment, and materials industries to remain competitive in this critically important, rapidly changing arena.

◆ replace and renovate obsolete scientific laboratory facilities now 30 to 40 years old with advanced research laboratories required to deliver the increasingly sophisticated measurements U.S. industry will need in the 21st century.

BACKGROUND AND JUSTIFICATION

Prior to FY 1993, funding for NIST laboratory programs had remained essentially flat for 20 years despite greatly escalated demands for NIST research and services. NIST's Advanced Technology Program and Manufacturing Extension Partnership were promising pilot programs funded well below levels necessary for national impact.

The late 1980s and early 1990s was also a time when technology policy scholars and politicians from both parties reached an important consensus. The past adversarial relationship between much of the federal government and U.S. industry was hurting the economy. The intense international competition for market share, the refocusing of many U.S. companies to address this competition with more directed R&D programs, and the accelerating speed of technological change were making it increasingly difficult for U.S. companies to finance the broader base of technologies that they had traditionally provided.

NIST was uniquely positioned to help remedy this situation. Through its laboratories, NIST had a 90-year history of successful cooperation with U.S. industry, a solid reputation for impartiality and scientific excellence, and an explicit mission to help manufacturers improve their competitiveness. In the last three years, NIST has used substantial increases in funding for its Advanced Technology Program, Manufacturing Extension Partnership, Laboratory Programs, and Office of Quality Programs to transform its operations. It has changed from a highly respected, but also highly constrained, source of measurement research and standards to a versatile federal technology agency providing critical support to the nation's economy.

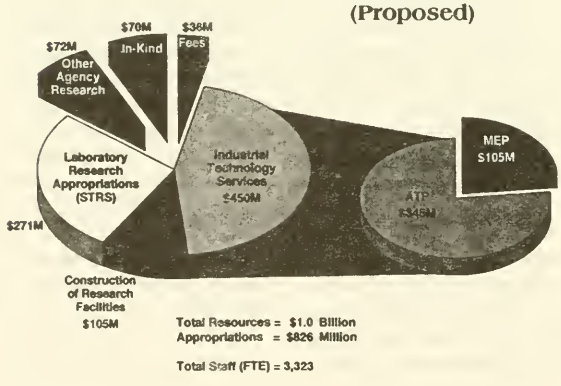
With a relatively small level of federal investment (about 1 percent of federal R&D spending), NIST has leveraged this portfolio of four interrelated, but very differently focused programs into an impressive number of accomplishments. It has put in place a set of civilian technology support systems that help strengthen the chain of innovation from basic research to commercialization of new technologies to use of those new technologies by U.S. manufacturers in the production of quality products. The ultimate goal of all these programs is steady growth of the U.S. economy, steady increases in high-wage jobs for American workers, and a rising standard of living for all U.S. citizens.

NIST has taken its new mandate very seriously. It has put programs in place that are rigorously competitive, based entirely on merit, and conscientiously evaluated. NIST's programs are true public/private partnerships. Both the ATP and the MEP require cost sharing by partners and both focus on investments that are expected to provide broad-based benefits to the economy.

The effect of NIST programs is to leverage money for the public good.

◆ The ATP does this by teaming with companies to tackle key enabling technologies that benefit both investors: the companies and the taxpayers. Cost-shared ATP projects advance the state of the technology, which creates

NIST Resources Fiscal Year 1997 (Proposed)



opportunities for the participating companies. As they spend their own dollars to take these new concepts into the marketplace, the technologies will enable important opportunities for customers, suppliers, and even competitors. These spillover benefits will flow through the economy, providing tremendous benefits for taxpayers.

◆ The MEP provides state and local agencies with an added measure of confidence that the funds they put up to help their local manufacturers stay competitive will have impact and will be well spent. The support of a national program ensures that each state's resources won't be used to constantly reinvent the "technology extension wheel" and that national experts will be available to help solve local problems. It also helps foster the nation's entrepreneurial spirit for small manufacturing, a sector that represents 50 percent of our manufacturing capacity and an important source for generating new jobs.

◆ NIST laboratories conduct long-term research that anticipates industry's needs for quality improvements and measurement methods. The Institute frequently serves as a neutral convener for whole industrial sectors—a place vendors, users, and competitors can discuss productively and construct research agendas to address issues of compatibility, quality control, and needed measurement tools or standards. And as one of the world's most respected centers of metrology—the interdisciplinary science of measurement—NIST tackles measurement challenges that no single company or group of companies could possibly undertake.

◆ Finally, NIST's Malcolm Baldrige National Quality Award program provides both guidance on quality improvement strategies that work and an added incentive of international recognition that helps U.S. companies focus on the continuous improvements in products and processes needed for marketplace success.

The United States needs these four NIST programs for all these reasons, and because we want current positive trends to continue. Exports are at an all-time high. New businesses are forming at record speed. High-wage jobs now account for over 50 percent of the new jobs being created, compared with 20 percent in 1991. The NIST FY 1997 budget proposal represents an investment in the nation's future economy that we cannot afford *not* to make.

PROGRAM DESCRIPTIONS

Advanced Technology Program

Established in 1990, the ATP has provided co-funding to individual companies or industry-led joint ventures for nearly 300 high-risk R&D projects with the potential for broad-based benefits to the economy. These projects involve a commitment of more than $900 million in federal funds and more than $1 billion in private-sector funds over their lifetimes.

ATP funding has helped prevent many U.S. research and development teams from having to give up on promising but risky ideas. The list of technologies now much closer to commercialization includes bioreactors that grow blood cells outside the body, CD-sized disks that store 18 hours of video, molecule magnets that remove trace quantities of precious metals or environmental contaminants with unheard-of efficiency, and microlasers that soon may transform flat-panel displays.

ATP co-funding often has brought together various sectors of an industry—and even direct competitors—to share research, cross-test ideas, and jump-start progress on complex research problems that would have taken years longer or never been tackled at all without ATP involvement. The 2mm project of the Auto Body Consortium joined eight small manufacturers, Chrysler, General Motors, and two universities to produce new technologies, manufacturing practices, and training techniques that substantially improved the fit of auto body components. The result will be more satisfied customers and more competitive products for the domestic auto industry, which affects one out of every seven jobs in the United States.

ATP's focused programs demonstrate clearly the potential for economic benefits flowing from ATP projects to the larger economy. These programs maximize the leverage provided by ATP funds by soliciting proposals in areas selected by industrial consensus that promise broad-based

economic benefits and require completion of a number of interdependent research projects.

The ATP focused program in Information Infrastructure for Healthcare is a case in point. Studies indicate that a full 20 percent of the nation's $1 trillion healthcare cost is related to the processing of information. A seamless, user-friendly information infrastructure is the critical ingredient for reducing those costs by many billions of dollars. But existing efforts in healthcare information technology lack the coordination and integration needed to share information nationwide and to develop tools that aid, not hinder, the healthcare provider. The ATP is helping industry lay the foundation for the more efficient use of computer technology in doctors' offices, hospitals and clinics by cost-sharing with industry the development of innovative new enabling technologies—technologies that will allow the medical community to reduce paperwork, improve the quality of diagnosis and treatment, and bring better medical care to rural areas. The beneficiaries of the ATP focused program will extend well beyond the individual companies and consortia that are cost-sharing and conducting the research. If the technical challenges can be overcome, the benefits will reverberate throughout the economy and the beneficiaries will be our entire citizenry.

Even though the ATP has been in operation for only six years, the program already has convincingly demonstrated a number of near-term, relatively immediate impacts. A recent survey conducted by Silber & Associates of 125 companies and non-profit organizations participating in ATP projects awarded in the first three years of the program found that:

◆ Seventy percent of the companies interviewed reported that there was little or no chance that they would have pursued the technology now under development without ATP support.

Programs That Work: A Sampling

Advanced Technology Program

◆ In 1992, Aastrom Biosciences Inc., Ann Arbor, Mich., had 15 employees and big dreams. They had demonstrated on a small scale that human blood cells could be grown in an artificial environment—an advance that promised to greatly improve treatment of patients with cancer, AIDS, and genetic blood diseases. They needed to scale up the process to produce 100 times more cells, enough to make the process clinically feasible. They won an ATP award that same year and got to work. Today, two years after completing their ATP project, the company has 45 employees, a prototype clinical process, and $20 million in private investment funding to develop their new blood cell bioreactor into a commercial product. "The ATP award was really pivotal to us for accomplishing our goals," says Walter Ogier, a company vice president. "To invest those quantities people like to have more than just proof-of-principle."

◆ MicroFab Technologies Inc., Plano, Texas, received ATP cofunding in 1993. The small, 18-person company wanted to apply its expertise in microjet printing to manufacturing integrated circuits but couldn't afford the research funding on its own. Three years later, the company has produced a new technology for "printing" tiny solder drops on circuit boards, a much more efficient and environmentally benign method than current technology. The ATP award helped the company attract additional funding for product development from a consortium of six electronics manufacturers. "We would still have been struggling to show feasibility without the ATP award," says MicroFab vice president David Wallace.

◆ When it won ATP co-funding in 1992, Nanophase Technologies Corp., Burr Ridge, Ill., was a "fragile little skunkworks, with one world-class scientist, one assistant and a nearly empty lab," says CEO Robert Cross. The ATP funding helped the company refine and scale up its process for producing ultrafine ceramic powders. The high-temperature-resistant powders can be heat pressed into complex parts like piston heads and turbine blades with little or none of the machining required for conventional metal or ceramic parts. Shortly after finishing its ATP project, the company began selling quantities of an unexpected spinoff product—powders for use in sunscreens and other cosmetics. The particles are smaller than light wavelengths so they are transparent when mixed with a lotion and spread on the skin, yet they block harmful ultraviolet rays almost completely.

Manufacturing Extension Partnership

◆ Manufacturing Development Inc. (MDI), Cheney, Kan., needed to meet stringent new standards required by the Boeing Company or risk losing its largest customer. The 30-person sheet

◆ Of the balance, 90 percent said that if they had gone ahead with the research without the ATP, they would have done so with significantly lower goals and/or at a significantly slower pace. "We would have been much slower, probably three years out," commented one respondent, "which in this industry is forever."

◆ Respondents also said that the ATP award stimulated collaboration and formation of strategic alliances, accelerated commercialization of technologies, created new business opportunities, increased the credibility and standing of project participants with competitors and customers, and enabled participants to attract additional funding.

Another study by the U.S. General Accounting Office for the House Science Committee found similar results. In a survey that included 89 companies that worked on ATP projects as the lead or sole organization during the first four years of the program, only 40 percent said they probably would have pursued the research without the ATP's support, and virtually all of those said the research would have gone significantly slower without ATP's help.

The true measure of the ATP's worth will not be known for some time. The real goals of the program are long term—to catalyze broad economic benefits for the economy. This will happen only when products and technologies based on ATP projects enter the marketplace and, in turn, enable others in the economy to introduce new and better products of their own.

Even here, however, there is good news available. The Silber study described above found that ATP projects produced a lasting change for some participants—"one which led them to rethink their traditional ways of doing business, particularly with regard to collaboration, information sharing, and investment in research. The mind set of U.S. industry, according to a number of participants, is to empha-

metal fabricator asked the Mid-America Manufacturing Technology Center for help. The center's technical staff provided the company with on-site training in statistical process controls and helped it secure a state grant that paid for half of the training costs. The training helped MDI earn supplier certification from Boeing while improving its overall operations. The company estimates that it will achieve a 50 percent reduction in scrap, reduce rework by 25 percent, and realize annual savings of $132,000.

◆ Working with the Minnesota Manufacturing Technology Center, Phoenix Industries, Crookston, Minn., has transformed from a 20-person company making primarily replacement parts for a dwindling market into a 150-person company using new technology to tap a booming new market—personal watercraft. Phoenix started out manufacturing wind turbine blades but had to quit the business when designs became too large for their production facilities. The Minnesota center helped the company switch its operations to injection molding of plastics, including purchase of a $350,000 system and training of employees. Recently, the company landed a multimillion dollar contract to produce hulls for personal watercraft that should keep the company's production facilities working to capacity for the next year.

◆ Applied Solar Energy Corp., Industry, Calif., implemented improvements recommended by the California Manufacturing Technology Center that saved the company $3 million in one year—the same amount received by the CMTC in 1995 federal funding as an affiliate of NIST's Manufacturing Extension Partnership. The company is the world's leading commercial producer of space solar arrays and subassemblies used in satellites. The center assessed the company's production process yields and recommended a number of suggestions that would decrease mechanical breakage. The company used its savings to hire 56 additional employees, for a total of 250.

NIST Laboratory Program

In the early 1980s, NIST began efforts to measure and quantify the economic returns on the agency's research and services. Conducted by independent researchers under contract to NIST, the studies have estimated the "social" rate of return, which is the aggregate rate of return for all investment in the technology generated by specific projects. For example, the social rate of return for a new NIST Standard Reference Material would compare the cost of supporting NIST research to develop the SRM with data collected from private industry on net cost savings produced through the SRM's use.

Such estimates are conservative because they are based only on quantifiable benefits to companies and consumers and don't include qualitative benefits such as improved customer satisfaction. To date, 12 such studies have been completed. The median rate of return is 147 percent. This rate of return is much higher than those reported in studies of most other public investments in technology and also higher than typical returns received by compa-

size short-term profits, a mentality one person called a 'fatal flaw' of American industry. The ATP, participants say, encourages and allows companies to focus on long-range technological development."

The $345 million funding level requested for FY 1997 will restore the program to approximately its FY 1995 post-rescission level, will continue support for all currently committed ATP projects, and will allow funding of a general and additional focused competitions.

Manufacturing Extension Partnership

The NIST Manufacturing Extension Partnership has helped thousands of smaller companies beat the odds and stay in business. From small beginnings with only seven centers in early 1993, the MEP now has 60 centers in 42 different states and Puerto Rico. Many of these centers, in turn, maintain multiple field offices throughout their coverage areas. Consequently, the program now provides geographically accessible extension services to four-fifths of the more than 381,000 U.S. manufacturing companies with fewer than 500 employees.

Establishment of these centers and field offices has come about only through the partnership implied in the program's name. Each center must raise matching funds from state, local, and private sources to support its operations and must demonstrate regularly why its approach to assisting local manufacturers will provide the best service compared with other possible providers.

Some of the early start-up funding for establishing the MEP network has been provided by the Defense Department's Technology Reinvestment Project (TRP). The MEP then has

panies for R&D investments, using the same estimation methods as the NIST studies. Some highlights:

◆ NIST research produced a tenfold improvement in the measuring accuracy of watt-hour meters, which are used to measure consumers' power usage. A 1994 analysis estimated that the broad economic benefits through more accurate customer bills and better traceability to the national standard exceeded NIST costs by a ratio of 41 to 1.

◆ A 1995 study found that NIST research to improve measurement of optical radiation—including ultraviolet, visible, and infrared light—produced a benefit to cost ratio of at least 13 to 1. This was based on an estimated annual benefit to the measurement equipment, lighting, and photographic equipment industries of about $3.4 million.

◆ Over the past decade, NIST research in measurement of electromagnetic compatibility/interference has helped electronics manufacturers to improve research efficiency and reduce transaction costs. The estimated social rate of return for this work was 260 percent.

Malcolm Baldrige National Quality Award

◆ Armstrong World Industries Building Products Operation is the world's largest manufacturer and marketer of acoustical ceiling systems for commercial and residential markets. BPO has 2,500 employees working at its Lancaster, Pa., headquarters and seven manufacturing facilities. A winner of the 1995 Malcolm Baldrige National Quality Award, the company has used quality improvement strategies to generate and distribute "best practices" throughout the company, to raise output per employee by 39 percent and annual sales per employee by 40 percent since 1991, and to improve its on-time deliveries to 97 percent. Safety is integrated into the process; in 1994, the BPO employees worked over 3 million hours without a "lost-time" injury, a company and industry record.

◆ Another 1995 Baldrige winner, Corning Telecommunications Products Division, Wilmington, N.C., is the world's largest manufacturer of optical fiber. The company uses a formal, documented process management system to control and continuously improve over 800 processes throughout its business and manufacturing operations. Process capability for key parameters such as glass diameter and fiber curl has improved steadily over the last three years. The company's quality management systems helped double productivity per employee between 1987 and 1994. Ninety-two percent of the company's customers rate the company "excellent to very good," and in 1994 only 250 out of every 1 million reels of optical fiber were returned due to defects.

managed the TRP centers as integrated parts of its national network.

A competition planned for late FY 1996 will allow the MEP to establish approximately 15 additional centers. In addition, under the Administration's FY 1997 budget proposal, MEP will assume funding for 15 extension centers it now manages as part of its network, but which were funded originally by the TRP. With implementation of the President's FY 1997 budget, the MEP will have in place a national extension service providing sorely needed assistance to thousands of smaller U.S. manufacturers yearly.

According to a recent General Accounting Office survey of manufacturers using at least 40 hours of MEP or other extension center services supported by state governments, 73 percent of respondents reported that they believed assistance from extension centers had positively affected their overall business performance. Specific areas cited most often were positive effects on the companies' use of technology in the workplace, the quality of products, and the productivity of workers. Those companies that committed resources for the purchase of new equipment or other improvements recommended by extension center personnel reaped the largest benefits. Of these companies responding, 86 percent reported that the advice they received positively affected their business performance.

An earlier study by MEP found that 610 companies served by the 13 centers in operation in 1994 anticipated benefits totaling $167 million or eight times the federal investment in MEP that same year.

Services provided by MEP centers will not keep a weak company from going under or ensure success for a strong one. Rather, such services help smaller manufacturers overcome the inherent isolation and lack of coverage for every needed type of expertise that comes from functioning within a small organization. Typical MEP services include helping small manufacturers access information on new equipment such as automation systems, find high-quality consultant advice for optimizing manufacturing systems, reduce costs by lowering waste and reducing the environmental impact of their operations, improve quality and expand markets for products, and find financing for modernization efforts.

NIST's MEP funding helps ensure that the infrastructure exists so small manufacturers can get the help they need when faced with complex choices. It provides a small measure of stability in the inherently volatile world of small business by providing smaller companies with some of the same resources available to large corporations. It greatly expands a small company's access to knowledge about new technologies and reduces isolation by hooking them into a nationwide set of experts available though electronic mail, the World Wide Web, and other national networks.

Full funding of the Administration's request for MEP will secure the program on a solid national footing; will provide an estimated 20,000 smaller companies with services that would otherwise be very difficult, if not impossible to obtain; and will help ensure that smaller U.S. firms have a fighting chance at competitiveness in the global marketplace.

NIST Laboratory Research

NIST laboratory research provides the often invisible, but absolutely essential measurement infrastructure needed for modern society to function. When a common commodity such as an automobile requires thousands of parts, each supplier of those parts must have reliable ways to ensure that a millimeter in Poughkeepsie is the same as a millimeter in Portland. Pocket cellular phones, air bags, heat-seeking missiles, fax machines, video game players—such products require length measurements many times smaller than the eye can see, as well as precision measurements of voltage, frequency, velocity, pressure, radiation, and temperature.

As one of only a handful of premier measurement laboratories in the world, NIST provides U.S. industry with a major competitive advantage not only by continually improving ways to measure basic quantities like length and temperature but also by developing a host of industry-specific measurement methods for quantities like materials' strain in circuit connections or the optical performance of flat-panel displays. And because NIST collaborates with industry researchers before, during, and after a project is

completed, NIST measurement know-how is quickly shared with the private sector. It is a truism of measurement science that an industry must be able to measure its products well before it can hope to make them to high standards of quality—the 1990s' prerequisite for capturing market share. At the same time, the benefits from development of these measurement methods are shared so broadly that individual companies have neither the incentive nor the specialized expertise needed to develop them on their own.

During FY 1995 and FY 1996, NIST laboratory programs have continued their long-standing reputation for productive partnerships with U.S. industry; for the highest quality basic science in support of metrology; and for development of measurement methods, reference materials, and data that lower the cost and improve the quality of U.S. products. For example:

◆ A team of NIST manufacturing engineers announced success in an eight-year effort to create the Molecular Measuring Machine, or M^3. The novel instrument may do for the molecular frontier what invention of the sextant did for mapping and exploration of the New World. The instrument can image the spaces between atoms and yet its field of view is 250,000 times larger than that of commercial instruments, which allows greatly enhanced precision in navigating and measuring the features of a molecular surface.

◆ Another new instrument developed by NIST electronics researchers with Digital Instruments of Santa Barbara, Calif., may provide the breakthrough measurement tool semiconductor manufacturers need to produce the next generation of computer chips. The scanning capacitance microscope can produce quantitative images of important chemicals called dopants with a resolution of 20 to 30 nanometers (billionths of a meter).

◆ NIST researchers working with colleagues from the University of Colorado cooled rubidium atoms to the lowest temperature ever achieved (170 billionths of a degree above absolute zero) to create an entirely new state of matter predicted 80 years ago by Albert Einstein and Indian physicist Satyendra Nath Bose. The Bose-Einstein superatom will help physicists better understand quantum atomic effects and in the process may lead to a new kind of "atom laser."

Other major achievements have included production of a DNA Standard Reference Material to improve confidence in DNA profiling for forensic or paternity cases using the relatively new polymerase chain reaction technology that requires only a few cells for an analysis, establishment of a new capability for using computer models to better understand the behavior of advanced materials, and improved calibration of mammography equipment through a NIST facility providing new NIST reference X-ray beams.

The Institute recently signed its 600th Cooperative Research and Development Agreement (CRADA) since this mechanism for working with U.S. industry was established by Congress in 1988. In 1995 alone, NIST signed 81 new CRADAs, just one of many ways in which NIST researchers collaborate with U.S. industry colleagues. Of these new agreements, 53 percent are with small businesses, 32 percent are with medium/large businesses, 6 percent are with universities, and 9 percent are with other organizations such as trade associations.

Funding of the FY 1997 NIST laboratory research appropriation will support development of an extensive line-up of measurement technologies anxiously awaited by U.S. industry, including:

◆ improved measuring methods and reference materials for minimizing transmission errors in fiber-optic connections used in high-speed communications systems;

◆ calibration techniques for a new class of "hexapod" machining centers that use an unusual support structure to cut parts faster and more accurately than conventional systems;

◆ new solid-state sensors, separation methods, and other capabilities to produce less expensive, more efficient chemical processing;

◆ advanced dosimeters for electron beam therapy used in cancer treatments to increase the safety of the technique and better assess its effectiveness;

◆ computer models that predict the effect of cracks on the performance of new high-technology concrete formulations;

◆ understanding of the mechanisms and effectiveness of new environmentally friendly silicon/silicone-

based flame retardants for reducing the flammability of plastics; and

◆ test methods and tools to improve the ability of various network technologies to provide user-defined levels of service required for voice, video, and multimedia data delivery.

An FY 1997 increase of $3.4 million is requested for NIST Laboratory Research to augment NIST's semiconductor metrology efforts. The metrology demands of this critically important field are constantly escalating in difficulty and cost, while the time scales available to produce them shrink along with the size of integrated circuitry. Managers for top semiconductor corporations estimate that measurements account for 25 to 35 percent of the cost of semiconductor devices. Past experience has shown that investment in semiconductor metrology is highly leveraged with benefits to the U.S. economy being two to five times more than the cost of NIST's work.

The current effort will concentrate on better ways to evaluate the design and performance of packages used to protect complex semiconductor devices, measurements of smaller feature sizes on lithography masks, ways to check feature sizes with patterns built into semiconductor wafers, and sophisticated techniques for detecting and eliminating trace-level contaminants in semiconductor processing systems.

This year the NIST Laboratory Research appropriation request also includes $3 million to maintain NIST's management of the Malcolm Baldrige National Quality Award. With a very small federal investment, the award has produced striking results in improved use and understanding of quality concepts throughout the U.S. business community. The award criteria, which double as quality improvement guidelines, have been reproduced widely and distributed by companies and other organizations and are driving quality improvements in all sectors of the U.S. economy.

Concrete evidence of the criteria's value was demonstrated recently through a hypothetical investment experiment. An investment in each of the publicly traded Baldrige winners from the first business day in April in the year the company won the award to August 1995 yielded a 248.7 percent return on investment compared with a 58 percent investment for the Standard & Poor's 500, outperforming the S&P 500 by more than 4 to 1.

Construction and Major Renovation of Facilities

More than $2 billion worth of NIST facilities are deteriorating at an accelerating rate. The Gaithersburg, Md., site built over 30 years ago, and the Boulder, Colo., site built over 40 years ago, feature 45 specialized laboratory buildings used to conduct a wide range of advanced measurement research. A NIST plan to upgrade its facilities through a $540-million, 10-year effort began in FY 1993.

During the first three years of this effort, NIST was appropriated $102 million for FY 1993, $60 million for FY 1994, and $35 million for FY 1995. In FY 1996, $60 million is included in the continuing resolution; however, in the same bill $75 million is slated for rescission from current and prior balances.

An independent study conducted for NIST in FY 1991 found that the overwhelming majority of NIST's facilities will fail to meet program needs within this decade unless steps are taken now to design, construct, and renovate the needed facilities. In its 1995 annual report, the NIST Visiting Committee on Advanced Technology commended the construction program that was in place at the start of 1995 and recommended that it be executed. The decaying state of the Institute's facilities already has made it impossible to provide some U.S. manufacturers with essential services, such as state-of-the-art calibrations urgently needed to maintain production-line quality controls on a par with overseas competitors.

Environmental controls regulating temperature, humidity, vibration, and air cleanliness that were more than adequate when the buildings were first constructed are now completely inadequate for atomic-level research. In addition, NIST power supplies are becoming less reliable and lack the capability of delivering clean power required by sensitive equipment. Since nearly all modern experiments rely on sensitive equipment to collect and analyze data, the poor quality of NIST power supplies regularly results

in inaccurate measurements, costly delays, rework, and loss of data.

Full implementation of NIST's construction plans will bring its most critical facilities up to U.S. industry's measurement needs through the year 2010 and beyond. NIST's long-range facilities improvement plan includes construction of new world-class, advanced technology laboratory space in both Gaithersburg and Boulder, as well as major renovation of existing buildings at the two sites. The FY 1997 funding requested will allow NIST to begin construction of the first phase of the Advanced Technology Laboratory in Gaithersburg.

Failure to fund this request will leave NIST without the tools necessary to carry out its mission in support of industry and the public. The upgrade of NIST facilities is long overdue. NIST researchers have already employed every stop-gap measure at their disposal, including ubiquitous plastic sheeting to protect sensitive laser tables from grit-delivering air vents and multiple mechanisms for isolating sensitive instruments from vibration. Without the new advanced research facilities it will be increasingly difficult, and ultimately impossible, to provide the advanced metrology demanded of a premier measurement laboratory.

Technology Administration
Appropriation Budget Summary
FY 1995–FY 1997
(Figures are in thousands of dollars)

	FY 1995 Approp.[a]	FY 1996 Estimate[b]	FY 1997 Request
US/OTP	8,242	5,000	9,531
NIST	699,654	579,396	825,984
Industrial Technology Services (ITS)			
Advanced Technology Program	340,528	255,396	345,000
Manufacturing Extension Partnership	74,222	80,000	105,000
National Quality Program[c]	3,400	0	0
Subtotal	418,150	335,396	450,000
Scientific & Technical Research & Services (STRS)			
Laboratory Research and Services	246,865	256,100	267,764
National Quality Program[c]	0	2,900	2,980
Subtotal	246,865	259,000	270,744
Construction of Research Facilities (CRF)			
Construction and Major Renovations	34,639	(15,000)[d]	105,240
NTIS	7,706[e]	0	0
Proposed Presidential Investment Addbacks[f]	0	69,104	0
Total TA Appropriations	**715,602**	**653,500**	**835,515**

[a] Reflects post-rescission appropriations available. The following rescissions were taken in FY 1995: US/OTP - $1,758K; ITS - $106,523K; STRS - $17,621K; CRF - $30,000K; NTIS - $294K.

[b] FY 1996 estimate based on current Continuing Resolution levels.

[c] Funding for National Quality Program transferred from ITS to STRS in FY 1996.

[d] Pursuant to P.L. 104-99, $75M is rescinded from current and prior year balances.

[e] NTIS is historically a self-supporting agency. In FY 1995 it received a one-time appropriation for modernization purposes.

[f] Proposed Presidential Investment Addbacks to FY 1996: ATP - $44,604K; MEP - $20,000K; US/OTP - $4,500K.

Dr. PRABHAKAR. Thank you. That's super.

I am here today to represent the Department of Commerce's Technology Administration which includes my own organization, the National Institute of Standards and Technology (NIST). Dr. Mary Good, who is our Under Secretary for Technology, is in Japan today with the President and Secretary Mickey Kantor. She is finishing up some duties that fell to her in the aftermath of the plane crash a couple of weeks ago.

Gary Bachula, who is our Deputy Under Secretary for Technology, is here with me today and he is going to answer all the tough questions about the Technology Administration.

Let me just start my few remarks this afternoon with some fundamentals:

Before his untimely death earlier this month, Secretary Brown was talking with people around this country about America's advantages. Surely one of America's greatest advantages is our vigorous market economy, that fierce entrepreneurship, the dynamic competition that really make for a powerful engine.

In recent years we have also been learning about the value of cooperation. We see this between industry and government, but also among companies and between industry and universities.

The President said in his State of the Union Address this year that self-reliance and teamwork are not opposing virtues; that we really must have both. In the arena of R&D, I think we are beginning to see just how powerful this concept is.

We are beginning to see that entrepreneurship and partnership are not opposites, but they can co-exist; that competition and cooperation can co-exist; and in fact that these build upon and fuel each other.

I think that is the reality of what drives our market economy that is very important to us.

Another fundamental that shapes our environment is that we are living in a time of deep and wide change in our economy and throughout our society. Two major factors are driving that.

One has to do with the globalization of markets, creating both tremendous opportunity and tremendous challenges for our competitiveness; and

Secondly, the pace of technological change continues to accelerate. If you just consider information technology and the dramatic changes it is creating throughout our economy and society, I think you begin to see how vast those changes can be.

These shifts are creating a variety of changes in our national technology system and how we perform research and development throughout this country. There are some changes that I believe are very significant:

We see companies shifting to narrower, more focused research and development which is great for companies but avoids many of the spillovers that were important in our broader economy.

We see new demands for measurements and standards infrastructure in the global economy.

We see that it is harder now for smaller manufacturers to keep pace with an economy that is being driven not just by their competition from down the street but from competition around the world.

And, we believe that these changes really demand that we rethink the way the taxpayers invest in R&D and that we need to re- examine the myriad other policies that determine how our whole innovation system works.

That is really the backdrop against which we do our work in the Technology Administration. We are trying to build the tools and the techniques that will help move our technology system, and hence our economy, into this next century.

The elements of the Technology Administration include the policy efforts within the Office of the Under Secretary and the Office of Technology Policy, and in the programs that we run at NIST.

Let me just start with the Office of the Under Secretary and the Office of Technology Policy.

This activity is the only source today for the data on technology and industry that are so important as we make government policy decisions, and as individual companies make their investment decisions about R&D and about manufacturing around the world.

I think that really is something that is unique. Unfortunately, it is unique. There really are no other sources to turn to for that kind of capability.

These offices are also an advocate for industry in many other arenas of government policy. They work to make sure that the decisions that are made around the government are done in a way that enhance rather than hinder our industrial innovation system.

This office also represents our technology interests in many international agreements that are under way. The Under Secretary chairs the Civilian Industrial Technology Committee of the National Science and Technology Council and who coordinates the Partnership for A New Generation of Vehicles; and, starting in recent months, has been working now to develop a new and a stronger relationship with state R&D organizations, an element in our strategy that we think really needs to be expanded.

The bottom line is that the Office of the Under Secretary, and the Office of Technology Policy, have started to give us for the first time the kind of information that illuminates the decisionmaking process for policies that affect U.S. innovations. This is work that is vital, and it is work that becomes more important with every passing year as technologies force growth.

So we really are standing firm behind the Office of Technology Policy and the continued support for the Office of the Under Secretary.

Let me turn now to the programs within the National Institute of Standards and Technology.

Our programs at NIST are only about 1 percent of the $70 billion that we often hear about that the Federal Government spends on research and development. Even though we are only 1 percent, we carry a very important responsibility, and let me tell you why.

Taxpayers spend that $70 billion-or-so on research and development not just to create more science and technology. They are making that investment because it is key to economic growth, to national security, to the health and welfare throughout our society.

And when you consider that, and then you subsequently consider that NIST's 1 percent of that pie is really intended to create the investments in technology that underpin our broader economy and

enable that much bigger public investment, the $70 billion, to link not just to companies anywhere in the world, but link to the companies that will bring value into the U.S. economy; that I think helps explain why we believe that this small piece is actually a very critical one and one very worth focusing on.

That explicit focus on underpinning technologies for economic growth is the reason we come into work in the morning, and I think that is why you will find, I believe, that there is no other part of the investment that delivers more economic bang per buck, and in fact I would challenge you to find any other part of the federal investment that delivers more for the economy. I think that is really where we live and breathe.

Let me describe for you the approach that we bring to our investments.

The first key issue for us has to do with the appropriate role for taxpayer dollars. There has been a lot of discussion—and I fear much heat and not much light—in this discussion about the appropriate role for Federal support of research and development.

We have been struggling with terms like "basic" and "applied" research to try to capture this very complex and interwoven technology and science system that we have. I think that has not actually worked very well.

As we look at our investment decisions at NIST, we believe that the core issue is the question of who pays, who invests, and then who benefits. I really want to focus on that. That is the heart of our investment decisions.

What that means is, if we find technology jobs where the beneficiary is an individual company, we say gee that is nice but it is not for us; it is not our problem. We look for those opportunities where the technology enables much broader benefits throughout the economy. Those are the areas where private companies do not invest and increasingly move away from; those are the areas where a public investment in research and development will have tremendous leverage not just for an individual company but for the broader economy.

So that first question of what that appropriate role for taxpayers' dollars is, that is our first key in our approach.

A second key issue is that in our approach we use industry's views to drive our priorities. This is rooted in an understanding that, after all, it is industry that turns technology into profits—products and services, and it is from those products and services that we create in our economy the profits and jobs that drive us forward. Therefore, we think industry's window into the marketplace is essential for us to understand how to set our priorities for where the best underpinning technologies can be pursued.

A third key for us is that we rely on rigorous merit-based competitions. Every award in our extramural programs is made on a competitive basis. We do not think there is any better way to spend the taxpayers' dollars, and politics explicitly does not enter into that process.

Then finally we believe that, to maximize the value of our investments, it is essential for us to continue to focus on economic evaluation of the benefits of our programs.

NIST has four major programs. Our laboratories, dating back to 1901 as the National Bureau of Standards, provide a common language measurement to support manufacturing and commerce and R&D.

Mr. Tanner gave an excellent example in the health care world.

The Advanced Technology Program is a program in which we partner with industry to drive the enabling technologies that hold dramatic promise again for the broader economy and the future.

In Manufacturing Extension we work with state and local governments to provide access to the information and expertise that small manufacturers need to upgrade their capabilities and to continue to compete in the global economy.

Then finally in our fourth program, the Malcolm Baldridge National Quality Award, our efforts, very small efforts at NIST, are really the linchpin of a vast private-sector effort that defines and evaluates quality practices in business.

In each of these four programs we have had I believe a very strong, clearly documented track record of delivering value. Last summer we released a report that was sent to each of your offices called "Delivering Results". It is really a snapshot in time that explains how each of those programs are serving the taxpayer in terms of providing value for our developing economy.

The written testimony that I have submitted details these programs, and also provides an explanation on the construction funding that we have requested. This is to support the continuation of our ability to perform the NIST laboratory mission.

Let me just summarize by saying that NIST's work and the work of the Office of the Under Secretary and the Office of Technology Policy are a very small but I believe a crucial part of our national innovation system.

Our traditional efforts and our new programs are designed to address the important challenges for public investment in today's rapidly changing world.

We believe that it is time to step up to these new realities in the global economy and to deliver for the American people.

Thank you again for your time today. I am happy to answer your questions, along with Gary.

[The prepared statement of Dr. Prabhakar follows:]

U.S. DEPARTMENT OF COMMERCE

TECHNOLOGY ADMINISTRATION

STATEMENT OF ARATI PRABHAKAR

DIRECTOR

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BEFORE THE

HOUSE SCIENCE SUBCOMMITTEE ON TECHNOLOGY

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Madam Chairwoman and Members of the Subcommittee, thank you for this opportunity to discuss the work of the Commerce Department's Technology Administration, including the National Institute of Standards and Technology. I appreciate the chance to brief you on our efforts to date to strengthen the U.S. economy and our plans for the future.

Madam Chairwoman, I will surprise and astonish no one with the observation that the world has changed greatly in the past decade. On just a few fronts, we have seen dramatic breakthroughs in DNA research, the world-altering collapse of the former Soviet Union, and the revolution in information technologies.

What is relevant for the Technology Administration is that the world also has changed greatly for our partners — the hundreds of thousands of private firms, from tiny start-ups to giant companies, that are the source of America's economic strength. Our challenge is to keep pace with a changing world, to embrace a culture of constant evaluation and change while recognizing and preserving those strengths that have kept our country strong.

Several factors set the context for our work.

- **We are a market economy, long one of America's great advantages.** Innovation and production are driven primarily by the needs, the market judgments, and the inspiration of private industry.

- Another strong tradition which has served us well is **sharing the responsibility for research and development between the public and private sectors**. This goes back to the post-WWII understanding that science and technology are vital components of both national security and economic prosperity. The private sector remains the major source for R&D funding in the United States, but the federal government has long invested significant public dollars in R&D for the common good.

These are basic strengths of our system that must be preserved. But consider the relatively new factors introduced by a changing world:

- More than ever before, **markets are global**. Goods, funds and information move freely around the world. No matter how big or small the company, it can have competitors both down the block and on the other side of the globe.

- The pace of **technological change is faster than ever**. The days when a company's investment in a product or process could be recouped over decades are largely gone, and in arenas like information technology, product cycles are more typically measured in months.

These factors have important implications for our economy's future:

- Vigorous competition and accelerated technology cycles have driven **industrial R&D to center more on shorter-term, narrowly focused projects** and less on longer-term work that can benefit other players. While this trend is improving many individual companies' internal return on R&D spending, it also means that companies no longer have the luxury of pursuing those technologies that might create broader opportunity for the economy. As the Council on Competitiveness' recent study, *Endless Frontiers, Limited Resources*, explains, "Less and less of the approximately $102 billion the private sector allots to R&D is spent on longer-range research -- the kind of research that ensures continued economic growth."

- Globalization means that **a healthy U.S. infrastructure for measurements and standards is more critical than ever**, while the acceleration of technological change increases the challenge in keeping that infrastructure healthy. Measurement tools and techniques must race to keep up with the explosion of needs in new areas like biotechnology and information technology, as well as the expanding needs in areas spanning manufacturing, materials, chemicals, and electronics. At the same time, American companies can no longer count on their product standards being the *de facto* world standards, a situation that mandates new thinking in the relationships among the many players in the U.S. private voluntary standards system.

- Implementing new technology and manufacturing practices can give U.S. companies the competitive edge they need in the global marketplace, but modern technology does not come easy. **Competitive pressures and the pace of technology change have made it harder and harder for small and medium-sized manufacturers to adapt to stay competitive.** A 1993 National Research Council report noted that these companies, which are an essential element of the manufacturing "food chain", represent more than 98 percent of U.S. manufacturers and provide more than 40 percent of manufacturing jobs. Generally, said the Council, these companies lack the expertise and resources necessary to upgrade their operations to take advantage of the technology edge.

In today's global marketplace, technological leadership means the difference between success and failure — for companies and countries alike. Technology is driving growth in every major industrial economy in the world today, and foreign competitors are running at our heels or ahead of us in many of the technologies that will shape the future — and many are ready to invest even more. Governments everywhere have recognized the link between technology and growth, and are developing policies and programs to enhance business competitiveness and fuel technology-driven growth and job creation. Both industrialized nations — such as Japan, Germany, and France — and rapidly industrializing nations — such as Korea, Singapore, and Taiwan — are pursuing policies aimed at giving their nations' corporations a competitive edge in world markets. These competitive pressures will only continue to intensify.

Since World War II, Americans have demonstrated an unwavering bipartisan commitment to U.S. technological leadership. Investments in science and technology have created a technology base that is the envy of the world, and have paid rich dividends — generating new industries, millions of jobs and higher living standards. Every president from Truman to Clinton has supported a strong role for the federal government in building the nation's scientific and technical capabilities. This sustained commitment to civilian research and development has delivered an enormous bang for the buck for American taxpayers. Efforts to cut the United States' investment in civilian technology represent a significant departure from this model of success and, if enacted, could jeopardize America's technological leadership and our children's economic future.

In addition to creating a healthy business environment, the Federal government must also optimize its enormous annual investment in science and technology. In FY 1996, the U.S. taxpayers are slated to invest more than $71 billion in research and development across a broad array of disciplines. We must seek to maximize the economic benefits of this investment through a coordinated and integrated national technology policy.

The Clinton Administration has sought to address the new economic and competitive realities by developing policies and programs — in partnership with American industry — that enhance U.S. competitiveness in the global marketplace and maximize technology's contribution to national economic growth, job creation and quality of life. President Clinton has articulated a clear role for government in fostering the development of civilian technology in partnership with industry, and emphasizes the creation of a favorable business climate. The Commerce Department's Technology Administration (TA) serves as the focal point for these efforts, advocating an agenda to ensure that American companies and workers have the tools needed to compete and win in today's global economy.

The Commerce Department's Technology Administration consists of the Office of the Under Secretary for Technology, the National Institute of Standards and Technology, the Office of Technology Policy, and the National Technical Information Service. My remarks today will not cover any of the outstanding efforts of the National Technical Information Service, an agency dedicated primarily to the collection and dissemination of scientific and technical information generated by the Federal government, since they are fully self-supporting and do not receive a Federal appropriation.

Office of the Under Secretary/Office of Technology Policy

The Technology Administration's Office of the Under Secretary/Office of Technology Policy — USOTP — is the sole Federal agency charged with developing and promoting national policies to maximize technology's contribution to U.S. competitiveness. For decades, the U.S. government has played a significant role in the

development of new technologies to meet the mission requirements of Federal agencies; these Federal research and development activities constituted a de facto technology policy. USOTP seeks both to maximize the effectiveness of Federal investments in R&D through an integrated technology policy that encourages the commercialization of government-supported research, as well as through policies that create an economic, trade and regulatory environment that supports the innovative efforts of the private sector.

USOTP recognizes the increasingly important role technology plays in economic growth, job creation and the quality of American life. Accordingly, USOTP has adopted an "industry as customer" focus, working with U.S. industry to facilitate the development, diffusion and commercialization of new technologies by advocating pro-innovation policies and removing unnecessary barriers to innovation through efforts such as regulatory reform.

USOTP has a long track record of success in this arena. In 1984, the agency — then the Office of Productivity, Technology and Innovation — drafted legislation for the National Cooperative Research Act which removed antitrust barriers to cooperative R&D. In 1986, USOTP helped craft the Federal Technology Transfer Act which promotes cooperation between national laboratories and U.S. industry in technology development.

USOTP also serves as an advocate for American industry in removing legal and regulatory barriers. USOTP advocacy on behalf of the U.S. pharmaceutical industry was instrumental in the National Institutes of Health decision in April 1995 to drop the "reasonable pricing" clause from its cooperative research and development agreements. This provision was viewed by industry as a significant barrier to partnership with NIH.

In addition, USOTP acts as a forceful advocate for reinventing our environmental regulatory system. In dozens of meetings with industry, the Environmental Protection Agency, and other administration officials during the past two years, USOTP has advocated moving away from the current "command and control" approach towards an incentive-based system in which government sets the performance standards and allows industry to determine how best to achieve them.

USOTP's advocacy is helping alleviate restrictions on the export of pharmaceuticals and other medical products — restrictions that were encouraging U.S. companies to move their manufacturing and R&D operations overseas. In April 1995, the FDA announced its intention to work with Congress on legislation to allow the export of pharmaceuticals and medical devices to 21 industrialized countries without prior FDA approval.

USOTP plans to build on its record of success during FY 1997.

The Under Secretary will continue to chair the Civilian Industrial Technology Committee of the President's National Science and Technology Council. Through this committee,

the Under Secretary helps to establish clear national goals for Federal science and technology investments and to ensure that Federal civilian R&D priorities reflect the requirements of industry partners.

The Under Secretary also remains the principal U.S. government representative for technology on the U.S.-Japan Economic Framework Talks, the U.S.-Egypt Partnership for Economic Growth, the U.S.-Israel Science and Technology Commission, and the Presidential initiative to support the peace process in Northern Ireland.

In FY 1997, the Office of Technology Policy's analytical work will be focused primarily in the areas of manufacturing and competitive assessments, assessing the impact of fiscal, tax and regulatory policies on the U.S. climate for innovation, and assessing the technical capabilities, technology and policies of our key trading partners. OTP will also continue to work with U.S. industry to advocate pro-innovation policy reforms and facilitate government-industry technology partnerships.

OTP will advance these objectives through continuation of several key initiatives. OTP's Meeting the Challenge initiative undertakes analyses on the competitive status of U.S. firms in several key American industries. These competitive assessments, made through the eyes of the stakeholders — industry, academia and government — will continue in FY 1997.

OTP will continue its Manufacturing Assessment initiative. The global competitive position of American manufacturing has been a concern to U.S. policy makers for several decades. More than ever before, manufacturing is the linchpin of our complex economy — allowing firms to transform inventions into products for world markets. Because of the important role that manufacturing plays in the innovation process, and the direct role that R&D plays in developing new manufacturing technologies and processes, USOTP has engaged in an assessment of the competitive position of U.S. manufacturing. The results of this ongoing work will provide a clearer understanding of what American manufacturing looks like today, the current trends, strengths and weaknesses, and our competitive position in the world economy. In turn, this knowledge can be put to use by OTP, Congress and other federal policy makers in developing and refining a wide range of policies — economic, technology, trade, regulatory, defense, education and training — to improve the competitiveness of American manufacturers.

The USOTP FY 1997 budget request also includes an increase of $375,000 to support the Under Secretary's role as chair of the high-level coordinating committee overseeing the Partnership for a New Generation of Vehicles (PNGV) initiative. This partnership involves eight Federal agencies, the Nation's automakers, and hundreds of suppliers working to achieve R&D goals in three areas: advanced manufacturing methods; technologies that can lead to near-term improvements in automobile efficiency, safety, and emissions; and research that could lead to vehicle prototypes with a threefold improvement in fuel efficiency. USOTP serves as PNGV Secretariat coordinating the

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participating Federal agencies, providing liaison with USCAR — the entity representing the auto industry in the partnership — and providing basic record keeping for the program.

OTP will also continue its support for the U.S.-Israel Science and Technology Commission which was announced by President Clinton and Prime Minister Rabin in March of 1993. The memorandum of understanding with Israel was signed in January 1994, and OTP serves as the U.S. Secretariat. USOTP is seeking $2.5 million in FY 1997 to continue this effort.

National Institute of Standards and Technology

The mission of the National Institute of Standards and Technology is to work with industry to promote economic growth for our country by developing and applying technology, measurements, and standards. In implementing this mission, NIST relies on four basic tenets to guide its work:

- NIST focuses on critical jobs vital to the country's technology infrastructure that neither industry nor the government can do separately. These are technology jobs that private companies cannot or will not take on by themselves — because they cannot capture the broad-based benefits that will accrue to the economy at large, or because the time-frame is too long and the risk too great. We consider the **appropriate role** for the taxpayers' money by asking, "Who pays and who benefits?"

- Industry drives all of our priorities and plays a critical role in helping us to carry out our work. **Industry's priorities**, not government's, guide NIST's work.

- Rigorous, open, technically sound and **competitive processes** are the hallmark of all our efforts. All of NIST's programs are strictly merit-based and have long been executed free from political influence.

- We rely heavily on **evaluation** of our work to ensure that industry and the taxpayers are receiving the greatest possible return on their investment.

With that as background I would like to review for the committee the NIST portfolio of programs that we have developed to strengthen the nation's economy. As you know, we are in the extraordinary position this year of submitting a budget request for FY 1997 without yet knowing what our budget for FY 1996 will be. I will not pretend that multiple furloughs and continuing budget uncertainty have had no effect on our agency, but I think it is a tribute to the quality of our staff that morale has remained as high as it has. I believe this is because the Technology Administration staff know they are engaged in important work for the public and the nation's future.

NIST Laboratory Programs

The oldest by far of our programs, begun as the National Bureau of Standards in 1901, the NIST laboratories occupy a unique niche in our nation's science and technology infrastructure. Measurement science, the core of the NIST laboratories, is an area where industry historically under invests. This broad science of metrology ranges from highly specialized research into the basic phenomena that underlie fundamental measurement standards such as mass and time to the development of specific test methods and standards for particular industrial and scientific needs and the gathering and evaluation of critical scientific and engineering data.

By their nature, measurement standards and technologies — like a language — must be shared by all and owned by none to be useful. In fact, measurement *is* a language, the *lingua franca* of research, trade and commerce. While all firms benefit from NIST measurement research in one way or another, it would be extremely difficult for any company or industry to recover the R&D costs required to develop these technologies. Moreover, the *risk* in developing measurement technologies is unacceptably high for private firms for the simple reason that all companies must adopt and use the same measurement standard for it to be of any utility. If several companies were to develop competing approaches to the same measurement problem, only one can be successful — the entire development costs of all the others would have to be written off.

Because of their unique role, the impacts of the NIST laboratories are pervasive not only throughout all of U.S. industry and commerce, but in most other facets of national life as well, including health care, safety and environmental monitoring. Perhaps one of the most telling evidences of the importance placed on the NIST laboratory programs by the U.S. science and technology community occurred last summer, when 25 Nobel Laureates in physics in an unprecedented show of support for a government program said of the NIST labs, "it is unthinkable that a modern nation could expect to remain competitive without these services."

Indeed, few people even get up in the morning without the aid of an alarm clock whose setting and accuracy ultimately derives from key research breakthroughs at NIST — derives, in fact, from world-class physics research such as last summer's historic creation of a new state of matter, a "Bose-Einstein condensate" of rubidium atoms cooled to less than 170 billionths of a degree above absolute zero. NIST scientists working with colleagues at the University of Colorado used techniques similar to those used to research improved time and frequency standards to cool the atoms to a temperature 300 times lower than has ever been achieved in a laboratory, and a billion times colder than any temperature found in nature.

The research projects undertaken by the NIST laboratories are as varied as our primary clientele, companies of all sizes, and range over virtually every field of science and

engineering. Chemical and food processors; manufacturers of all sizes; high-tech industries such as computers, aerospace, and information technologies; and more traditional industries including steel and concrete makers; biotechnology firms; instrument makers; hospitals and clinics; and many others depend on the measurement support of the NIST laboratories.

What are the pay-offs? They vary, of course, from sector to sector, but investment in the measurement infrastructure pays handsome dividends to the economy as a whole. An instructive case study was completed this past fall by Dr. Albert Link, a Professor of Economics at the University of North Carolina.

Link used industry surveys and economic analysis tools to examine the impact of one specific NIST measurement service, the Facility for Automated Spectral Calibration (FASCAL) laboratory.

Established by the Radiometric Physics Division of the NIST Physics Laboratory in 1975, the FASCAL lab automated the calibration of the 1,000-watt quartz halogen tungsten lamps used in industry as radiometry standards — that is, standards for the amount of light generated by a source (radiance) or falling on a surface (irradiance). There are three major classes of industrial users of the FASCAL lab: manufacturers of radiance and irradiance measurement equipment such as Hoffman Engineering and RSI, lighting manufacturers such as Phillips and Osram Sylvania, and photographic equipment manufacturers such as 3M and Kodak. In 1995, the sales for these three industries totaled about $39 billion. The Department of Defense is a fourth major user of the lab.

The lab cost about $250,000 to set up, and net annual costs are about $150,000.

Link surveyed representative companies in each of these three industries to determine the extent to which they relied on the FASCAL lab. The survey respondents were nearly unanimous in the opinion that the FASCAL lab was very important to their industry in general and their company in particular. Typical comments included, "Traceability through the FASCAL laboratory gives you confidence in your data and it saves time arguing with customers so that productive work can be done," and "The standards have a tremendous impact ... they make products comparable on an international basis," and "If the FASCAL laboratory closed, our company would have to spend a lot more time trying to achieve the same level of accuracy that we now have," and "Even with foreign laboratories [if there were no FASCAL], lack of accuracy would cost people in society hundreds of millions of dollars simply because users of my equipment would be making inaccurate environmental forecasts."

One likely benefit of the FASCAL lab, according to industry respondents, is an increase in product quality due to a reliable national standard for evaluating product performance. But since this proved to be a difficult notion to measure, Link attempted to quantify the impact of the FASCAL lab, by asking the companies surveyed to estimate the probable

increase in *disputes* with customers if there were no FASCAL lab to provide commonly agreed-upon standards, and how long it typically took to resolve such disputes in terms of payroll hours. Extrapolating the answers to the annual workload of the FASCAL lab, Link found that — ignoring any benefits to industry from improved product quality — the FASCAL lab probably saved industry $3.4 million *each year* in reduced transaction costs alone. That's a conservative benefit-to-cost ratio of **nearly 13 to 1 on one single NIST laboratory service.**

Other pay-offs from NIST laboratory research are harder to quantify but just as real. Women undergoing mammography exams at accredited U.S. facilities soon will have much improved assurance of receiving proper X-ray exposures thanks to a new calibration facility established at NIST earlier this year. X-ray exposure is one of the critical parameters in mammographic procedures. The new facility will allow the operators and inspectors of more than 10,000 U.S. mammography centers to trace the accuracy of their X-ray exposure measurements to the primary mammography X-ray standards at NIST. NIST is now one of only two national standards laboratories in the world to provide primary standards for mammography.

As the former National Bureau of Standards, the NIST labs pioneered cooperative research agreements between government and industry in the 1910s, long before the acronym "CRADA" was in vogue. That tradition continues strongly today. Last year NIST participated in 420 Cooperative R&D Agreements with industry, including 81 new CRADAs — 53 percent of which were with small businesses. And formal CRADAs represent only a small part of our many, more often informal, interactions with industry. We also hosted over 1,200 researchers from universities, companies, and other labs who came to NIST to work under a variety of guest and research associate programs. These talented researchers play an important role in the health of the NIST labs, both in leveraging our resources and keeping our work closely tied to the public we serve.

The NIST labs also participate in several industrial consortia that bring together groups of companies and government labs to attack key technology challenges in their industries. Last year, we participated in 14 research consortia including two new ones, one on improved air-flow measurements with the makers of instrumentation used to control air flow in the clean rooms used by semiconductor and pharmaceutical industries, and one with manufacturers and trade associations in the roofing industry to evaluate the performance new materials used in water-proofing roofs.

The Administration's FY 1997 request for the NIST laboratory programs is $270 million, a modest 4 percent increase over the estimated FY 1996 budget. Most of this increase will go to augment our chronically under funded semiconductor metrology efforts. I might note that previous NIST research efforts to advance the state of the art in semiconductor metrology have produced benefits for the U.S. semiconductor industry — a $83-billion-a-year business — of at least two to five times more than the cost of the NIST work. The measurement technology developed under this initiative will help U.S.

industry to produce the smaller, faster, more powerful and less expensive semiconductor devices needed to compete in a cut-throat global market.

Advanced Technology Program

The goal of the ATP is economic growth and the good jobs and quality of life that come with economic growth. It represents the public interest in — and investment in — a strong and growing economy for the United States, opening new opportunities for U.S. business and industry in the world's markets by fostering enabling technologies that will lead to new, innovative products, services, and industrial processes. For this reason, ATP projects focus on the technology needs and opportunities of U.S. industry, not those of government. The ATP is industry driven, which keeps the program grounded in the real world. Research priorities for the ATP are set by industry: companies conceive, propose, co-fund, and execute ATP projects and programs based on their understanding of the marketplace and research opportunities.

Who pays? The ATP has strict cost-sharing rules. Joint ventures must pay at least half of the project costs. Single companies working on ATP projects must pay all indirect costs associated with the project. (This provision encourages small companies, particularly start-ups, which can have much lower overhead rates than large firms.) On the average, the split is about even. The 280 awards announced by the ATP since its inception in 1990 commit a total of $970 million in ATP funds and $1 billion in industry funding, assuming all projects are pursued to conclusion.

This only covers the pre-product, enabling research funded by the ATP, of course — research that underlies the development of new products, processes, and services across diverse application areas. Since the ATP does not fund product development, private industry bears the considerably greater costs of product development, production, marketing, sales, and distribution.

The ATP awards process is one of the most highly examined competitions of its kind in government, and it has received high marks for efficiency, integrity and effectiveness. ATP awards are made strictly on the basis of rigorous competitions designed to select the proposals that are best qualified in terms of the technological ideas, the potential economic benefits to the nation (not just the applicant), and the strength of the plan for eventual commercialization of the results. Expert reviewers (without conflicts of interest) drawn from the business community, government, and academe carefully examine and rate each proposal according to published selection criteria that focus on both business and technical potential. Political considerations are not part of the selection criteria.

The ATP works by encouraging a change in how industry approaches R&D. The globalization of markets and the pace of technology change continue to drive private

R&D to a narrower, shorter-term focus. In sharing the relatively high development risks of technologies that potentially enable a broad range of new commercial opportunities, possibly across several industries, the ATP fosters projects with a high pay-off for the nation as a whole. The nature of ATP projects, risky but broadly applicable, stimulates joint research ventures that link small suppliers with users, or that link several firms together to solve a generic problem common to all.

Who benefits? In the near term, the companies and consortia that work on ATP projects benefit, of course, as they should. The ATP is far from a handout; the companies that successfully propose and pursue ATP projects invest considerable resources of their own on ventures that carry a significant risk.

But in the long run, the benefits of ATP projects go far beyond the companies who made the initial effort. Criteria for individual projects and for focused programs make it very clear that NIST is seeking to promote industry's ability to take on technological challenges that will have broad economic impacts. The benefits will accrue not just to individual ATP participants but to entire industrial sectors and the economy as a whole.

The ATP focused program in Information Infrastructure for Healthcare is a case in point. Studies indicate that a full 20 percent of the nation's $1 trillion healthcare cost is related to the processing of information. A seamless, user-friendly information infrastructure is the critical ingredient for reducing those costs by many billions of dollars. But existing efforts in healthcare information technology lack the coordination and integration needed to share information nationwide and to develop tools that aid, not hinder, the healthcare provider. The ATP is helping industry lay the foundation for the more efficient use of computer technology in doctors' offices, hospitals, and clinics by cost sharing with industry the development of innovative enabling technologies — technologies that will allow the medical community to reduce paperwork, improve the quality of diagnosis and treatment, and bring better medical care to rural areas. The beneficiaries of the ATP focused program extend well beyond the individual companies and consortia that are cost sharing and conducting the research. If the technical challenges can be overcome, the benefits will reverberate throughout the economy and the beneficiaries will be our entire citizenry.

The ATP benefits companies of all sizes. Large firms can work with the ATP, especially in joint ventures, to develop critical, high-risk technologies that would be difficult for any one company to justify because, for example, the benefits spread across the industry as a whole. For smaller, start-up firms, early support from the ATP can spell the difference between success and failure. To date, nearly half (46 percent) of the ATP awards have gone to individual small businesses or to joint ventures led by a small business. Universities and non-profit independent research organizations also play significant roles as participants in ATP projects. More than 100 different universities are involved in about 150 ATP projects as either joint-venture participants or subcontractors.

Since its inception, the ATP has made economic evaluation of the outcomes of ATP projects a central element of its operations. The ATP has developed and implemented a thorough measurement program that pushes the state of the art in evaluating the long-term outcomes of an R&D investment.

At present, it is impossible to measure the *full* economic effect of the Advanced Technology Program simply because it is too early for such effects to have occurred. Success of the ATP will depend ultimately on its ability to stimulate meaningful, broad-based economic impact for the nation. While only a handful of early projects are out of the ATP R&D phase and entering the commercialization phase, NIST has put into place systematic mechanisms to gather data and provide the analysis as the long-term effects unfold. These mechanisms include an information collection system for tracking the business progress and economic results of ATP projects; a series of microeconomic case studies of individual projects; the experimental use of macroeconomic models for projecting outcomes; and the development and application of approaches and tools for estimating the benefits not only to the participating companies and institutions working on the ATP projects, but to the industry as a whole, consumers, and the economy.

Near-term outcomes from the ATP, however, are available. In the past few months we have received the results of two separate but overlapping studies based on detailed surveys of ATP participants. One study, by the research firm Silber & Associates, was conducted as part of the ATP's evaluation program and surveyed 125 companies participating in ATP projects during the first three years of the program. A parallel study by the U.S. General Accounting Office in 1995 for the House Science Committee surveyed 123 firms which were lead applicants in winning or "near-winning" projects during the ATP's first four years.

Both of these studies offer strong evidence that the ATP is on track towards achieving its goal of delivering significant economic benefits to the nation. The results of these studies and others conducted by the ATP are thorough and detailed, but I can summarize the main points here. They document:

- the successful, and accelerated, development of new technologies and technical capabilities as a result of the ATP;
- company projections of reduced time-to-market based on ATP-supported technologies;
- early progress towards commercializing ATP-supported technologies; and
- company expansion and projections of future growth based on ATP-supported technologies.

The ATP also is having a real effect on the industrial R&D culture. Results show that the ATP is:

- encouraging industry to pursue more high-risk, enabling R&D projects, projects which would not have been attempted in the same time-frame without ATP support;

- encouraging companies to team with other firms to best take advantage of new markets; and

- promoting industrial R&D alliances both horizontally, among competitors, and vertically, between customers and suppliers — alliances which are leading to increased efficiencies in R&D and reduced time to market.

The Administration's FY 1997 request for the Advanced Technology Program is $345 million. This funding will enable us to support all current ATP projects for which multi-year funding already has been committed and will allow funding for one general competition and additional focused-program competitions in FY 1997. This figure would restore the ATP budget to approximately the level of the FY 1995 budget, after rescissions.

Manufacturing Extension Partnership

I noted earlier that one consequence of the globalization of markets and the rapid pace of technological change was that it has become increasingly difficult for small and medium-sized manufacturers to remain competitive.

The NIST Manufacturing Extension Partnership has helped thousands of smaller companies beat the odds and stay in business. From small beginnings with only seven centers in early 1993, the MEP now has 60 centers in 42 different states and Puerto Rico. Many of these centers, in turn, maintain multiple field offices throughout their coverage areas. Consequently, the program now provides geographically accessible extension services to four-fifths of the more than 381,000 U.S. manufacturers with fewer than 500 employees.

Like the ATP, the Manufacturing Extension Partnership emphasizes merit-based competitions, cost-sharing, and evaluation. Each center and field office that makes up the MEP, selected through rigorous competitions, must raise matching funds from state, local, and private sources to support its operations and must demonstrate regularly why its approach to assisting local manufacturers will provide the best service compared with other possible providers. Manufacturers generally pay a fee for any significant MEP services, and typically pay costs associated with implementing recommended changes in their operations.

Some of the early start-up funding for establishing the MEP network has been provided by the Defense Department's Technology Reinvestment Project (TRP). The MEP then has managed the TRP centers as integrated parts of its national network.

Last year the MEP made several important advances, including:

- conducting a national competition resulting in the addition of 18 new manufacturing extension programs to the MEP network, including new centers in Alabama, Arkansas, Florida, Idaho, Mississippi, Montana, New Hampshire, New Jersey, Utah, Vermont and Puerto Rico, and expansions to provide increased coverage in six states already affiliated with the MEP;

- conducting a national competition in partnership with the Environmental Protection Agency to support projects that will help smaller manufacturers address environmental concerns in the most cost-effective manner. Seventeen projects were selected for awards, including 11 projects to integrate new environmental technology assistance into existing manufacturing extension centers; five projects to develop new environmentally related technical assistance tools for use by manufacturing centers in serving their clients; and a pilot project to establish a National Metal Finishing Resource Center to provide easy electronic access to relevant, current, reliable and comprehensive information on pollution prevention opportunities, regulatory compliance and technologies and techniques for reducing pollution in the metal finishing industries.

- the establishment of four pilot projects at manufacturing centers to help small manufacturers to better understand, identify and access sources of financing and credit options.

A competition planned for late FY 1996 will allow the MEP to establish approximately 15 additional centers.

Services provided by MEP centers will not keep a weak company from going under or ensure success for a strong one. Rather, such services help smaller manufacturers overcome the inherent isolation and lack of coverage for every needed type of expertise that comes from functioning within a small organization. Typical MEP services include helping small manufacturers access information on new equipment such as automation systems, find high-quality consultant advice for optimizing manufacturing systems, reduce costs by lowering waste and reducing the environmental impact of their operations, improve quality and expand markets for products, and find financing for modernization efforts.

NIST's MEP funding helps ensure that the infrastructure exists so small manufacturers can get the help they need when faced with complex choices. It provides a small measure of stability in the inherently volatile world of small business by providing

smaller companies with some of the same resources available to large corporations. It greatly expands a small company's access to knowledge about new technologies and reduces isolation by hooking them into a nationwide set of experts available though electronic mail, the World Wide Web, and other national networks.

We have strong evidence of the success of the MEP centers in serving small and medium-sized manufacturers. According to a recent General Accounting Office survey of manufacturers using at least 40 hours of MEP or other extension center services supported by state governments, 73 percent of respondents reported that they believed assistance from extension centers had positively affected their overall business performance. Specific areas cited most often were positive effects on the companies' use of technology in the workplace, the quality of products, and the productivity of workers. Those companies that committed resources for the purchase of new equipment or other improvements recommended by extension center personnel reaped the largest benefits. Of these companies responding, 86 percent reported that the advice they received positively affected their business performance.

An earlier study by MEP found that 610 companies served by the 13 centers in operation in 1994 anticipated benefits totaling $167 million or eight times the federal investment in MEP that same year. When we consider that these companies are the backbone of our country's manufacturing sector, representing 50 percent of our manufacturing capacity and an important source for generating new jobs, the importance of the MEP to the nation is clear.

The Administration's FY 1997 request for the Manufacturing Extension Partnership is $105 million. This will enable the MEP to complete its expansion to a national network, including the funding needed for 15 extension centers it now manages as part of its network, but which were funded originally by the TRP. With implementation of the FY 1997 budget, the MEP will have in place a national extension service providing sorely needed assistance to thousands of smaller U.S. manufacturers yearly. Full funding of the Administration's request for MEP will secure the program on a solid national footing, will provide an estimated 20,000 smaller companies with access to services, and will help ensure that smaller U.S. firms have a fighting chance at competitiveness in the global marketplace.

Malcolm Baldrige National Quality Award

This year the NIST Laboratory Research appropriation request also includes $3 million to maintain NIST's management of the Malcolm Baldrige National Quality Award. A remarkably successful partnership of government and industry, the very small federal investment is leveraged by more than $100 million of support each year from industry. The Baldrige Award has produced striking results in improved use and understanding of quality concepts throughout the U.S. business community, and become both the U.S. standard of quality achievement in industry and a comprehensive guide to quality improvement.

The award criteria, which double as quality improvement guidelines, have been reproduced widely and distributed by companies and other organizations and are driving quality improvements in all sectors of the U.S. economy. To date, more than 40 states have or are in the planning stages of implementing state quality programs, most modeled after the Baldrige Award.

Concrete evidence of the criteria's value was demonstrated recently through a hypothetical investment experiment. An investment in each of the publicly traded Baldrige winners from the first business day in April in the year the company won the award to August 1995 yielded a 248.7 percent return on investment compared with a 58 percent investment for the Standard & Poor's 500, outperforming the S&P 500 by more than 4 to 1.

Construction and Major Renovation of Facilities

Finally, I would like to turn to a particularly grave issue — the steady erosion of the facilities the NIST laboratories need to deliver their vital services and support. More than $2 billion worth of NIST facilities are deteriorating at an accelerating rate. The Gaithersburg, Md., site built over 30 years ago, and the Boulder, Colo., site built over 40 years ago, feature 45 specialized laboratory buildings used to conduct a wide range of advanced measurement research. A NIST plan to upgrade its facilities through a $540-million, 10-year effort began in FY 1993.

During the first three years of this effort, NIST was appropriated $102 million for FY 1993, $60 million for FY 1994, and $35 million for FY 1995. In FY 1996, $60 million is included in the continuing resolution; however, in the same bill $75 million is slated for rescission from current and prior balances.

An independent study conducted for NIST in FY 1991 found that the overwhelming majority of NIST's facilities will fail to meet program needs within this decade unless steps are taken now to design, construct, and renovate the needed facilities. In its 1995 annual report, the NIST Visiting Committee on Advanced Technology commended the

construction program that was in place at the start of 1995 and recommended that it be executed. The decaying state of the Institute's facilities already has made it impossible to provide some U.S. manufacturers with essential services, such as state-of-the-art calibrations urgently needed to maintain production-line quality controls on a par with overseas competitors.

Environmental controls regulating temperature, humidity, vibration, and air cleanliness that were more than adequate when the buildings were first constructed are now completely inadequate for atomic-level research. In addition, NIST power supplies are becoming less reliable and lack the capability of delivering clean power required by sensitive equipment. Since nearly all modern experiments rely on sensitive equipment to collect and analyze data, the poor quality of NIST power supplies regularly results in inaccurate measurements, costly delays, rework, and loss of data.

The Administration's FY 1997 request for the Construction of Research Facilities at NIST is $105.2 million (including $98.9 million for our labs in Gaithersburg, Maryland and $6.3 million for our Boulder, Colorado labs.) Full implementation of NIST's construction plans will bring its most critical facilities up to U.S. industry's measurement needs through the year 2010 and beyond. NIST's long-range facilities improvement plan includes construction of new world-class, advanced technology laboratory space in both Gaithersburg and Boulder, as well as major renovation of existing buildings at the two sites. The FY 1997 funding requested will allow NIST to begin construction of the first phase of the Advanced Technology Laboratory in Gaithersburg.

Failure to fund this request will leave NIST without the tools necessary to carry out its mission in support of industry and the public. The upgrade of NIST facilities is long overdue. NIST researchers have already employed every stop-gap measure at their disposal, including ubiquitous plastic sheeting to protect sensitive laser tables from grit-delivering air vents and multiple mechanisms for isolating sensitive instruments from vibration. We are now beginning construction on a new chemistry building that addresses more immediate safety issues that cannot be delayed. Without more complete advanced research facilities included in our FY 1997 request it will be increasingly difficult, and ultimately impossible, to provide the advanced metrology demanded of a premier measurement laboratory.

Conclusion

In brief, Madam Chairwoman, NIST has responded to the challenges of the 1990s with a strong portfolio of programs well matched to the needs of U.S. commerce and industry. It has put programs in place that are rigorously competitive, based entirely on merit, and conscientiously evaluated. NIST's programs are true public/private partnerships. Each program focuses on investments that provide broad-based benefits to the economy.

With a relatively small level of federal investment (about 1 percent of federal R&D spending), NIST has leveraged these four interrelated, but very differently focused programs into a significant number of accomplishments. It has put in place a set of civilian technology support systems that help strengthen the chain of innovation from basic research to commercialization of new technologies to use of those new technologies by U.S. manufacturers in the production of quality products. The ultimate goal of all these programs is steady growth of the U.S. economy, steady increases in high-wage jobs for American workers, and a rising standard of living for taxpayers.

The effect of NIST programs is to leverage a public R&D investment for the public good.

- NIST laboratories conduct long-term research that anticipates industry's needs for quality improvements and measurement methods. The Institute frequently serves as a neutral convener, providing for whole industrial sectors a place vendors, users, and competitors can discuss and construct research agendas to address issues of compatibility, quality control, and needed measurement tools or standards. And as one of the world's most respected centers of metrology, NIST tackles measurement challenges that no single company or group of companies could possibly undertake.

- The ATP teams with companies to tackle key enabling technologies that benefit both investors and stakeholders: the companies and the taxpayers. Cost-shared ATP projects advance the state of the technology, which creates opportunities for the participating companies. As they spend their own dollars to take these new concepts into the marketplace, the technologies enable important opportunities for customers, suppliers, and even competitors. These spillover benefits will flow through the economy, providing tremendous benefits for taxpayers.

- The MEP provides state and local agencies with an added measure of confidence that the funds they put up to help their local manufacturers stay competitive will have impact and will be well spent. The support of a national program ensures that each state's resources won't be used to constantly reinvent the "technology extension wheel" and that national experts will be available to help solve local problems.

- Finally, NIST's Malcolm Baldrige National Quality Award program provides both guidance on quality improvement strategies that work and an added incentive of international recognition that helps U.S. companies focus on the continuous improvements in products and processes needed for marketplace success.

The NIST FY 1997 budget proposal represents an important, strategic investment in the nation's future economy.

I will be happy to answer any questions you might have.

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-0001
OFFICE OF THE DIRECTOR

Arati Prabhakar

Director, National Institute of Standards and Technology

Arati Prabhakar was appointed the tenth Director of NIST by President Clinton and took office in May 1993. An agency of the Commerce Department's Technology Administration, NIST promotes U.S. economic growth by working with industry to develop and apply technology, measurements, and standards. As NIST Director, Dr. Prabhakar oversees a staff of approximately 3200 and a budget of nearly $1 billion. In addition, she chairs the Committee on Applications and Technology of the Information Infrastructure Task Force.

Previously, Dr. Prabhakar served for two years as Director of the Microelectronics Technology Office in the Defense Department's Advanced Research Projects Agency (ARPA), where she had managed advanced electronics research since 1986. From 1984 to 1986, Dr. Prabhakar served as a Congressional Fellow in the Office of Technology Assessment.

Dr. Prabhakar is a senior member of the Institute of Electrical and Electronics Engineers and a member of the American Physical Society. She received her B.S. in Electrical Engineering from Texas Tech University (1979), and her M.S. in Electrical Engineering (1980) and Ph.D. in Applied Physics (1984) from the California Institute of Technology.

2/96

Mrs. MORELLA. Thank you very much, Dr. Prabhakar. You have submitted to the committee a very extensive testimony where you have given a number of excellent examples along the way, FASCAL being one of them, in terms of the $39 billion which they reaped in terms of the benefits of the kind of money that was put into the fund.

I just have a couple of questions, and then I will turn it over to others to ask questions for the first round.

When discussing NIST I think it is important that we point out more about the core laboratory functions. I know that there have been a number of new initiatives within the laboratory. I wondered if you would be willing to discuss some of the mission-related research and the basic-science research which is being done.

Dr. PRABHAKAR. Absolutely.

Usually the problem is getting me to stop when I start on that topic, so let me try to be brief.

[Laughter.]

Dr. PRABHAKAR. Obviously our core focus in the laboratories is on measurement standards, evaluated data, test methods—again this business of creating a common language. We find that our work therefore is very, very broad and touches virtually every part of our industrial structure, but it is very focused again on this business of the measurement infrastructure.

What that means is that today you will find us working with traditional industries as they move forward and working with some of the leading edge technology firms—semiconductor manufacturing is one example where we have worked with that industry for decades, but their measurement needs are very, very aggressive and continue to evolve very rapidly.

The fact that every time you go buy a personal computer you get more capability for fewer dollars resides in the fact that we are packing more and more capability onto integrated circuits.

When you start looking at the dimensions, the submicrometer dimensions, now that are being used in manufacturing, you begin to see how challenging the measurement issues are there.

That is why this year's budget request for Fiscal Year 1997 includes—we were only able to find the resources to include one expanded initiative, and that is in the semiconductor metrology area.

Some of the new things that we have been involved in again reflect growing, changing needs within the industry. One of those areas has been health care measurements in the last couple of years.

This is an area where—health care is obviously an area with tremendous investments in technology. Our role again has been this very focused effort on the measurement science and technology necessary to make sure that when we take cholesterol measurements, when we take any other kinds of blood samples, we are getting accurate, reproducible, reliable measurements throughout our system.

So I think that is an interesting example.

One of our major issues within the NIST laboratories today is how to deal with and how to provide our kinds of underpinning technologies for the information revolution.

We are in the process of creating a new Information Technology Laboratory. In the subsequent hearings about the specific labs at NIST we hope to have a chance to explore that in more detail with you.

But again, if you consider the interoperability and scalability challenges in the information revolution today are something like what we were facing in the industrial revolution 100 years ago, you start to see how challenging that task will be for us to figure out how we need to step up.

So we continue to serve some of the traditional needs as industries evolve, but we also try to keep pace with brand-new things that spring up in our economy. I think that is what is wonderful about technology, and racing to keep up with that keeps us very busy with our NIST laboratory investment.

Mrs. MORELLA. I remember in one of the visits we were brought into the laboratory with regard to measurements pertaining to breast cancer. So that is another part of the medical field.

Dr. PRABHAKAR. Exactly.

Mrs. MORELLA. I just always wonder how other laboratories, how business and industry can even keep up with what you are doing. And so it seems to me you need a tremendous dissemination effort to let them know so that they can avail themselves of that effort.

Dr. PRABHAKAR. That is absolutely right. But I think it is also worth noting that virtually everything we do is done with the rest of the technical community the way, again, we set our priorities for what we need to do in the laboratory. That starts by trying to understand where the industry is going and what their evolving needs will be.

And of course we are trying to make the investments now that will meet their needs some time in the future.

So it is not done in isolation. But you are absolutely right, that the workshops, the communication, the meetings, all of those things are an essential part of doing our work.

Mrs. MORELLA. I just have one other question for the first round. You have requested $105 million for the construction of research facilities. This amount will keep NIST moving forward with its 10-year modernization plan.

I wondered if you could give the subcommittee sort of an overview of the 10-year plan and where we are right now in that plan.

Dr. PRABHAKAR. We are in the process of re-evaluating that 10-year plan because of some of the bumps in the road. This was a plan that began in 1993. It was originally a $540 million objective to achieve that funding to do the construction that is needed for our labs to be able to function and do that measurement job for the next century.

We had several outside evaluations that established the need for those capabilities. We began in 1993 and received appropriations for the first few years, and started to build the funds to do this job as well as begin the planning and the architectural studies to make this all work.

What happened in the last year, in the last fiscal year, and we do not have our budget obviously yet, but we do know that what is in the appropriations language would provide for us an addi-

tional $60 million for construction but rescinds $75 million from prior-year balances.

The net effect of that is that we find today that we are in a very urgent situation requiring our new chemistry laboratory. That is the work that is just now beginning with the resources that we have in hand.

We still have a very urgent requirement to begin work on our Advanced Technology Laboratories, if we are to have the temperature, and the vibration stability, and the environment that we need to make these very complex measurements for the next century.

To make that happen, to make that new Advanced Technology Laboratory capability real, that is why we are requesting the $105 million in the Fiscal Year 1997 budget request. That will enable us to do the first phase of the ATL activities in Gaithersburg.

Until we have that money, we really are not going to be able to start to build this capability.

At the same time, we are rethinking and reworking the 10-year plan because obviously we are now three years into the original ten years and not where we needed to be in terms of the budget, so we are struggling to rework that plan and figure out what it will actually take—and, you know, what is the minimum to get by.

We know we need this initial phase of the ATL, and that is why we are starting with that in Fiscal Year 1997.

Mrs. MORELLA. So the critical figure then is that we look to the $105 million for next year, for the fiscal year that is coming up?

Dr. PRABHAKAR. That is going to be the critical piece, absolutely.

Mrs. MORELLA. Mr. Tanner, I turn it over to you for questioning.

Mr. TANNER. Thank you, Madam Chairwoman.

I may have been the only one, but I picked up about your methodology with respect to the ATP program. As you know, a 1995 CATO Institute report entitled "Ending Corporate Welfare As We Know It" implied, and some others on the committee have implied, that these ATP awards were made as political payoffs of some kind; that they go to people who have contributed to Democrats; that awards go to districts that elect Democrats and are based on political contributions.

Some have argued that this is a good reason to eliminate this program.

I would be interested in your response.

Dr. PRABHAKAR. My response is that those accusations are simply not true. The only basis for ATP awards has to do with technical quality, and the quality of the business plan that comes in with the proposals.

I actually think it is an insult to the companies that have struggled and have won in a very fierce competition to imagine that there was any other basis for the spending of those dollars. I think that is just preposterous.

Mr. TANNER. Are you familiar with the CATO Institute report?

Dr. PRABHAKAR. I have seen it.

Mr. TANNER. I would like whatever information you could give me to refute that, because I agree with what you have said. As a matter of fact, is it true that over 10 percent of the NIST laboratory funding comes from ATP?

Dr. PRABHAKAR. The arrangement in the legislation specifies that up to 10 percent of the ATP funds can be used to sponsor projects in our laboratories in support of the ATP projects.

In fact, we have had I think closer to about 4 percent in the last fiscal year, again, to provide some very critical supporting technical efforts in our labs.

Mr. TANNER. Talking about the labs, in last year's authorization bill the committee included report language which was also adopted by the Appropriations Committee that prohibited NIST from working in the areas of environmental technologies, information infrastructure, health care, and construction activities.

What kind of activities did this report language curtail?

And how did it, for example, impact the EPA/NIST Environmental Measurements' Proficiency Evaluation Sample Program which is one of the ways we can actually make an intelligent, rational decision about whether or not something is cost effective, which seems to be something that many people are interested in.

Let me stop there.

Dr. PRABHAKAR. Your point about the environmental measurements area is I think an excellent example of why we objected to that language. In fact, I have written a letter to the Committee Chairman—it is dated last August—and if I could I would like to submit that for the record.

It provides some greater detail on what those activities are all about, and essentially explains that in these areas of environmental technologies, health care information technologies, et cetera, that the work that we are proposing to do has to do with measurement standards, evaluative data, test methods—again, the core of what NIST does.

The environmental area is a very good example. It is simply not possible to move to the kind of performance-based regulation that so many feel is critical to have——

Mr. TANNER. Which I happen to agree with, frankly.

Dr. PRABHAKAR. (continuing) —a much more intelligent regulatory approach, but it simply cannot be done without the development of the measurement tools and techniques that assure traceability. That is exactly what we have been trying to do, and I think that is the core of this.

Of course in Fiscal Year 1996, again we do not have an appropriation. We have been operating under a Continuing Resolution. The effect of that has been that we have not been able to do any of those new initiatives for budget reasons as much as for language reasons right now.

Mrs. MORELLA. Without objection, that will be included in the record.

Dr. PRABHAKAR. Thank you.

[The letter referred to follows:]

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-0001

AUG 21 1995

Honorable Robert S. Walker
Chairman
Committee on Science
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

The Committee on Science's fiscal year 1996 authorizations for the National Institute of Standards and Technology's (NIST) Scientific and Technical Research and Services demonstrates clear support for the mission of the NIST Laboratories, and our role in promoting economic growth by working with industry. The report which accompanies the bill, however, demonstrates a fundamental misunderstanding of key NIST programs which support environmental technologies, health care, information infrastructure, and construction technologies.

The report claims that these four programs are not related to the core mission of NIST, and that they duplicate efforts in industry and other government laboratories. In fact, the activities in all four of these program areas involve development of new measurements, measurement methods, standards, reference materials, test methods, and reference data that are key to the respective industries.

Additionally, the activities in these four areas are carefully coordinated with industry and other government agencies specifically to avoid duplication of effort. This coordination--achieved through cooperative research and development agreements, interagency agreements and committees, and myriad contacts within the technical community--ensures that the programs are on target and will have impact. As you know, other government agencies, like companies, rely on NIST measurements and expertise to provide the foundation and quality assurance necessary to achieve vital elements of their missions.

NIST

A copy of a more detailed response to the report is enclosed, including specific examples of how NIST is making a difference to industry, other government agencies, and the public in each of these four areas.

Sincerely,

Arati Prabhakar

Arati Prabhakar
Director

Enclosure

cc: Committee on Science

August 18, 1995

NIST Position on House of Representatives Report 104-232

Summary

In its authorization of appropriations for fiscal year 1996, the House of Representatives Committee on Science affirmed NIST's unique role in developing and delivering measurement techniques, test methods, standards, and other types of infrastructural technologies and services. These infrastructural technologies and services provide a common language needed by industry in all stages of commerce--research, development, production, and marketing. No other organization in either industry or government performs this essential role.

However, in the report, House of Representatives Report 104-232, that accompanies the authorization bill (HR1870), there appears to be a fundamental misunderstanding of this role with regard to certain NIST programs in environmental technologies, health care, information infrastructure, and building and fire research. The report describes elements of these programs as 'insufficiently related to the core mission of NIST to justify the requested funding for fiscal year 1996.' The purpose of this response is to demonstrate how these programs exemplify NIST's core mission and how they will benefit the U.S.

Environmental Technologies

- The NIST laboratories support activities in environmental technology and environmental monitoring through development of infrastructural technologies--measurements, standards, reference materials, reference data, and test methods. No other agency has this measurement-based role. NIST carefully coordinates its activities with the other federal agencies involved in environmental technologies and provides the foundation and quality assurance for the measurements made by all these organizations.

- The committee report states that efficiency and competition are driving companies to reduce waste. That is why companies rely on NIST, now more than ever, to provide the technical infrastructure that is key to industrial process design and control, waste minimization and processing, and all types of environmental monitoring.

- *NIST has played a critical supportive role in the transition to environmentally safer refrigerant fluids. The Air Conditioning and Refrigeration Institute has identified NIST's evaluated data and models as key to the orderly and systematic replacement of chlorofluorocarbon chemicals, a process affecting over $300 billion of refrigeration equipment in the U.S.*

Health Care

• NIST services and research form the foundation for nationwide safety and quality-assurance systems that ensure the accuracy of health care measurements. For example, NIH relies upon NIST for measurement **accuracy** for calibration of instrumentation used in health care diagnostics and therapy. NIST also provides traceability to national standards required for regulatory, technical, and economic reasons. As examples, the FDA requires NIST traceability for medical devices (including biomaterials) and the NRC requires NIST traceability for radiopharmaceutical use.

• The proposed activities do not duplicate other efforts in government or industry, and in fact provide necessary support to those efforts. These essential federal activities are well-placed at NIST, since support for health care measurements is an area of well-established NIST expertise and experience, unique in the government.

• *According to a GAO report, accuracy of clinical measurements of cholesterol levels in blood has improved four-fold since NIST issued a benchmark human serum Standard Reference Material certified for cholesterol content. This improvement in uncertainty saves $1 billion per year in unneeded treatment costs.*

Information Technology

• Industry has identified **interoperability** as the major barrier to their development and use of information technology products. Historically, the information technology industry has not been able to develop the tools to assess conformity or interoperability of products because it is expensive and firms are unable to capture sufficient return on investments in such infrastructural technologies. Nevertheless, such tools are important because they promote market development for all vendors, and because interoperability enables a technical infrastructure which can benefit all users of consumers of information technology products.

• NIST's unique role is developing test methods, measurements and measurement techniques to determine the extent to which products interoperate, and developing the techniques and tools necessary to support interoperability testing. This work does not include developing industry's technology and commercial applications, as stated in the committee's report.

• *NIST supports the Standard for the Exchange of Product Model Data (STEP), which enables exchange of product-related information between computers. Leading suppliers of manufacturing software plan to incorporate the standard into their products. Major U.S. manufacturers view the standard as critical to shortening lead times for new products, tightening relationships with suppliers, and eliminating hardware and software incompatibilities. In the automotive industry, according to one estimate, costs due to incompatible CAD/CAM systems alone may approach $100 million annually.*

Fire Research

• This proposed work involves development of urgently-needed new measurement methods, data, computer-based models or related tools for evaluation of industry-produced technologies, or information protocols to facilitate interoperability of industry-produced construction products and equipment.

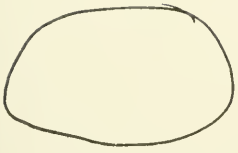
• The work is not, as the committee report suggests, duplicative of private sector innovation, but rather provides the infrastructure that facilitates private sector's innovation and implementation. This work is coordinated with other agencies through interagency committees, and has been endorsed by leaders of the construction industry.

• *NIST provides technical support for the National Conference of States on Building Codes and Standards (NCSBCS), which is made up of delegates appointed by the governors of the 50 states. Before this program was established, there were 40,000 jurisdictions with individual building codes. Now there are over 30 states with statewide building codes. NIST provides the research and services necessary to gain broad acceptance of uniform standards, enabling the states to carry out their programs in an efficient manner.*

Conclusions

Each activity identified by the committee report as inappropriate for NIST is in fact an unambiguous expression of NIST's core mission and each serves an essential and legitimate government role. For each activity, NIST's close collaborations with the private sector and other federal agencies ensure there is no duplication of effort, and that the activities will have impact. The committee report, unfortunately, shows a profound misunderstanding of the work performed at NIST.

Expanded NIST Responses to House Report 104-232 Accompanying HR 1870



August 18, 1995

Environmental Technologies

House of Representatives Report 104-232

"The Committee believes that efficiencies in manufacturing are driven by market forces and competition and do not necessarily require government involvement and subsidies. Waste elimination is recognized today as a key component of efficient resource management and companies are driven by competitive forces to identify and implement cost-efficient waste management strategies.

Major initiatives involving environmental management are ongoing at other agencies such as the Department of Energy, National Science Foundation, Environmental Protection Agency, and the National Oceanic and Atmospheric Administration, among others. For example, the fiscal year 1996 President's request for the Environmental Technology Initiative at EPA was $119.8 million--$51.9 million more than was appropriated in fiscal year 1995. The program request is duplicative of work that is ongoing at these agencies, which have substantially greater expertise than NIST in environmental technologies."

NIST Response

The Committee has too narrowly defined environmental technology activity to one of "waste elimination and management". Environmental technologies encompass a much wider range of activities, including: environmental monitoring, industrial processing and control, waste minimization, and such activities as improving the energy efficiency of buildings. NIST's unique role in environmental technology is to provide the accurate measurement base that is critical for informed decisions having significant economic and environmental implications. NIST supports and complements industry efforts to develop, commercialize, and use environmental technologies and are not duplicative of other agencies' efforts. All of NIST's activities in this area are consistent with NIST's core technology mission; none replaces private sector investment.

NIST has a demonstrated record of providing measurements, measurement methods, reference materials, and evaluated data that are the underpinning of many environmental technology areas. For instance, NIST has been involved in the acquisition of highly accurate measurements on the thermophysical properties of refrigerants and the development of models to predict thermophysical properties of alternative refrigerants. The Air Conditioning and Refrigeration Institute has identified NIST's evaluated data and models as key to the orderly and systematic replacement of chlorofluorocarbon chemicals as dictated by the Montreal Protocol, a process affecting over $300 billion of refrigeration equipment in the U.S. These data have substantially accelerated the progress industry has made in the design of new equipment and the modification of existing equipment to operate using these new refrigerants.

As another example, NIST has played a crucial and unique role in the effort to reduce the effect of environmental pollution from lead on human health, by advancing and maintaining the

measurement infrastructure for industry and other agencies. NIST Standard Reference Materials (SRMs) for lead in blood have been critical in improving the nation's capabilities to make measurements at lower concentrations (intervention level is now set at 100 parts-per-billion) and ensuring measurement quality in state and clinical laboratories across the U.S. NIST's continuing support of efforts to reduce lead exposure includes more than 40 SRMs with lead certified. NIST-developed lead-in-paint film standards are used in deciding if abatement of a site is required, thus ensuring that fair and economically-viable decisions are made and health hazards are eliminated. The economic impact of abatement decisions across the U.S. is estimated to be tens of billions of dollars.

The program is "not duplicative of work ongoing" at DOE, NSF, EPA, and NOAA. The NIST laboratories support activities in environmental technology and environmental monitoring through development of infrastructural technologies--measurements, standards, reference materials, reference data, and test methods; no other agency has this role. NIST carefully coordinates its activities with the other federal agencies involved in environmental technologies, including those cited. NIST provides the foundation and quality assurance for the measurements made by all these organizations. For instance, analysis of environmental pollutants often requires exacting measurements of low-level chemical concentrations. NIST enables companies and other federal agencies to perform such analysis by providing more than 200 different environmental Standard Reference Materials (SRMs) that allow the more accurate measurement of these pollutants in air, water, soil, and other materials. SRMs are critical in the validation of the methods and instruments used in chemical analysis. These SRMs are often produced in cooperation with other agencies, who rely on NIST for the development of accurate and reliable measurement methods. It should be noted that NIST does not establish or enforce regulatory standards; NIST's role is to ensure that these activities are based on good science and accurate measurements.

An example of the coordinated work done at NIST is a collaboration with the American Industry/Government Emissions Research Consortium (AIGER). This organization is an umbrella group which includes U.S. automobile manufacturers, the California Air Resources Board, and the EPA. The goal of NIST's efforts is to develop new measurement methods, reference materials, and reference data for the real-time measurement of several targeted chemical species in automotive exhaust. The research projects include development of a state-of-the-art primary flow calibration facility, new analytical techniques and sensors, and primary gas reference materials. Auto manufacturers will use these new measurement technologies to design cars that will meet EPA goals, Clean Air Act requirements, and the more stringent California emission standards.

In conclusion, global decisions involving remediation of atmospheric, terrestrial, and marine pollution, with projected costs of billions or even trillions of dollars are only as good as the measurements on which they are based. Advanced measurement infrastructure, including critical data and standards, is needed to ensure that fair and economically viable decisions are made, and

that real environmental hazards are correctly identified and abated. NIST, the nation's reference laboratory, plays a critical and unique role in this process.

Health Care

House of Representatives Report 104-232

The proposed, non-traditional NIST activities are duplicative of ongoing, major government initiatives at other agencies such as the National Institutes of Health and the National Science Foundation.

The United States leads the world in medical research, and boundless opportunities for innovation exist in the health care sector. Creative companies will seize these opportunities and develop new health care technologies and bring them to the market--creating new businesses and new jobs. Developed and marketed by individual companies, these preventive, diagnostic and treatment technologies will foster the growth and wealth of our economy and improve the quality of life in the United States and throughout the world. NIST expertise in these areas is less mature and government research efforts are better places in other centers of excellence within government"

NIST Response

NIST does not perform activities in health care that are either "non-traditional" or "duplicative of ongoing, major government initiatives at other agencies such as the NIH and the NSF."

The NIST laboratories have maintained for many years an effort in health care through development of infrastructural technologies--measurements, standards, reference materials, reference data, and test methods. This effort has resulted in wide-ranging interactions with the health care industry, other agencies (both local and federal), and academia. The NIST health care program extends from projects in chemistry, thermometry, and radiation --measurements that are critical to the accurate calibration of instrumentation used in health care diagnostics and therapy-- to research efforts supporting advances in biotechnology, analytical instrumentation, and dental care.

The NIST mission is complementary to NIH, which relies on NIST for measurement accuracy. In addition, NIH relies on the College of American Pathologists (CAP) for clinical proficiency testing and the CAP has collaborated with NIST since 1978 when it established a reference laboratory at NIST. The definitive measurements and reference standards developed at NIST are at the top of the clinical measurement hierarchy and the basis for secondary standards programs, proficiency testing, and the reference and routine methods practiced by the general clinical laboratory.

NIST provides traceability to national measurement standards required for regulatory, technical, and economic reasons. For instance, the FDA requires NIST traceability for medical devices (including biomaterials) and the NRC requires NIST traceability for radiopharmaceutical use.

The importance of standards cannot be overstated. The American Association of Physicists in Medicine (AAPM) has written " the issues related to standards development are in general too complex for other agencies to understand, and the relevance of standards to the missions of other agencies is not always fully appreciated...Standards development should stimulate the national economy by helping high technology industry to become more competitive. The AAPM urges NIST to increase the priority of the development of ionizing radiation standards". The 600,000 people who undergo radiation therapy for cancer each year and the several million more who undergo radiodiagnostic and radiotherapeutic procedures count on NIST calibrations, reference materials, and laboratory accreditation services to ensure the accuracy of radiation doses.

The role of standards is further illustrated by the impact made on one of the most common clinical measurements, cholesterol in blood. In 1980 and 1981, NIST developed a definitive method for serum cholesterol and certified cholesterol in Standard Reference Material 909, Human Serum. According to a GAO report (GAO/PEMD-95-8), this and subsequent NIST SRMs benchmarking cholesterol measurement have been instrumental in improving interlaboratory comparability (that is, the degree to which established test values vary from one laboratory to the next) almost four-fold from 1969 to 1990. It has been estimated that this improvement in uncertainty saves $1 billion per year in unneeded treatment costs.

In conclusion, NIST laboratories provide services and conduct research that form much of the foundation for nationwide safety and quality-assurance systems that ensure the accuracy of measurements performed in the health care industry. The Department of Health and Human Service reports that retesting accounts for between 10 and 25 percent of total annual health care expenses (between $90-220 billion in 1992). Even a one percent reduction in wasteful retesting results in savings approaching $1 billion. New measurement technology and standards developed and produced by NIST will improve cost effectiveness by facilitating the development of innovative diagnostic and therapeutic tools, and affect more accurate diagnoses.

Information Infrastructure

House of Representatives Report 104-232

"Most of the information infrastructure projects fall outside the traditional NIST mission, and collectively are the development of information industry technologies or commercial applications. As stated in NIST's fiscal year 1995 budget justification, 'high-performance computing and networking are generic technologies...' While the Committee recognizes the critical importance of high-performance computing, the Committee does not believe the government should duplicate industry efforts already underway. The proposed activity is not unique, as most of the work involves hardware, software, and data interchange efforts that are the heart and soul of a well-developed, aggressive and globally competitive industry, and for which the private sector's capabilities and resources are more than adequate to the task."

NIST Response

The NIST activities support the technical infrastructure needed by the information technology industry to promote and improve new technology development and deployment. NIST infrastructure services promote accessible markets, increased exports, and more timely access to information. NIST's activities focus on areas beyond the capabilities of either industry or government alone, but vital to the nation's technical infrastructure. NIST leverages our resources through collaborative efforts with industry in standards forums and consortia; and provide key **metrology support through development of test methods, simulations, and reference implementations or prototypes**; and laboratories and testbeds established at NIST. NIST collaborates with industry to develop test methods, metrics and tools to measure conformity to standards and interoperability among distributed functions which are key to the national information infrastructure.

NIST's efforts complement those of industry. It does not develop hardware, software, or commercial data interchange methods or applications which duplicate or compete with the private sector. NIST leverages its resources by collaboration with industry through standards bodies, industrial consortia and cooperative research and development agreements. NIST provides key metrology support to all segments of the Information Technology sector through focused research and development of techniques and analytic tools to assess design and validity of specifications during the design and development phases of standards; and metrics, test methods, test suites, reference data and scoring protocols to assess conformity with standards and interoperability of information technology products which are the foundations of an information infrastructure.

Industry has identified interoperability as the major barrier to the dissemination of information technology products[1,2,3]. Interoperability is the ability of two or more systems to interact with one another and exchange data according to a prescribed method in order to achieve predictable results.[1] A key component of interoperability is conformity to agreed upon specifications. Interoperability enables different vendors' systems to communicate or exchange data so that users do not have to account for differences in products or services; i.e., it implies compatibility among systems at specified levels of interaction, including physical interconnection, communications networks, data interchange formats, service control points within systems and interfaces for programs. It is precisely in this arena--interoperability and voluntary standards--where NIST's efforts are most needed, and most appropriate for government to provide.

Vendors within the information technology sector continue to differentiate their products from competitors' products through unique features. These features often make programming languages, databases, communications protocols, computer aided design systems, and other applications incompatible with competing products (including those based on "voluntary standards").

Interoperability implies that vendors' products implement the same features and services, in a compatible way, and that user's programs and data (information) are interchangeable. It also implies that computers, networks and telecommunications systems can work together to interchange information. For users of information technology in the private and public sectors, the ability to exchange information between application programs and vendors' products is an important criterion. Interoperability enables information exchange between heterogenous products, permits product choices and increases competition, and reduces costs if there is competition.

Historically, the Information Technology industry has not been willing to develop the methods, tools and test suites (measurement infrastructure) to assess conformity or interoperability of products on its own because it is expensive and individual firms or groups of firms are unable to capture sufficient return on their investments in such infrastructure technologies. However, such **tools are important in a competitive market because they promote market development for all vendors and promote interoperability of component technologies which enable the establishment of a technical infrastructure for the use of consumers of information technology products**. Furthermore, the industry sector looks to NIST as neutral broker and

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[1] *Perspectives on the National Information Infrastructure: Ensuring Interoperability*, Computer Systems Policy Project, Feb. 1994.

[2] *An Architectural Framework for the National Information Infrastructure*, Cross-Industry Working Team, Sept. 1994.

[3] *R&D for the NII: Technical Challenges*, Edited by Mary Vernon et. al., Proc. of Symposium, Feb. 28-Mar. 1994, EDUCOM, May 1994.

technically competent contributor to the development of testing and measurement methodologies for infomation technologies.

NIST's role is to collaborate with industry and standards bodies to:

• Identify requirements for critical product interfaces and information interchange standards; identify related standards and unmet needs; and help facilitate common understanding and access to information about standards.

• Develop test methods and measurement techniques that will allow buyers and sellers to determine the extent to which products interoperate

• Develop necessary specification, validation and analytic techniques and tools.

• Establish R&D collaborations, technology demonstrations, testbeds and laboratory facilities to address interoperability of prototypes and early products.

• Create an environment to enable identification of technical issues, barriers and constraints; and facilitate identification of agreed-upon solutions which industry incorporates into products.

These essential functions do not replace industry's efforts. Contrary to the Committee Report, these are unique activities that fall squarely within NIST's mission responsibilities.

25-434 O - 96 - 3

Building and Fire Research

House of Representatives Report 104-232

"The Committee believes that the construction industry is a playing field for individual companies, not the Federal Government. In today's diverse and fragmented marketplace, opportunities are abound for construction companies who seize the power of innovation and transform it into new technologies, products, and services. This mature industry is already driven by powerful competitive forces to produce innovations in the areas of construction techniques, building automation, and computer assisted design. In the new budgetary environment facing the Congress, scarce dollars can better be used on other, more important basic research needs."

NIST Response

Construction comprises a giant but disaggregated industry with small enterprises predominating. Private sector research is limited to development of proprietary products. Shortages of capital for R&D, inadequate interfaces among diverse products and practices, liability concerns, and regulations are barriers to innovation. The NIST program removes technological market barriers and reduces burdens of unnecessary or ineffective regulations while maintaining essential levels of safety. Private sector R&D is stimulated by this program's authoritative, nonprescriptive performance measures for construction and fire safety of materials, components, systems, and practices. NIST is the principal source of technical information for construction and fire safety standards which provide the technical basis for fire and building codes.

From its very beginning, NIST has been the Nation's leading laboratory for building and fire research. The technologies and standards associated with construction processes and the protection of life and property from natural and man-made disasters are highly interdependent, and they are important determinants of the quality and affordability of constructed facilities and the infrastructure. Only NIST has the expertise to integrate these functions, the relationships to partner with industry and the many intermediary organizations to orchestrate the needed extramural activity, and the ability to make the integrated whole fully responsive to national need.

The NIST core mission has included industry-requested measurement technology in the areas of building and fire research from its very inception. Specifically, every product of the proposed work involves development of urgently-needed new measurement methods, data, computer-based models or related tools as enabling infrastructure for evaluation of industry produced technologies, or information protocols to facilitate interoperability of industry produced construction products and equipment.

The construction industry[4] specifically endorses the NIST effort in regard to on site automation (on site sensors and automated equipment) and building services protocols (fire detection, security, and structural control). Further, the requested funding builds on ongoing activities being conducted in cooperation and/or direct collaboration with leading construction industry firms - e.g. Bechtel, Caterpillar, Fluor Daniel, Stone and Webster, PlantSTEP Consortium, BACnet Consortium.

Therefore, it is incorrect to state that the requested funding for support of automated construction processes and advanced facilities management is not directly related to NIST's core mission or that such work should not be done by the federal government. Moreover the proposed program addresses urgent needs requested by the construction industry. Congress has consistently, at the urging of this very industry, supported both the relevance and appropriateness of the NIST role in building and fire research.

It is true "this mature industry is already driven by powerful competitive forces to produce innovations...". The requested funding responds to this industry's expressed needs for infrastructure to enable them become more innovative and thus more competitive.

[4] *Notional Construction Goals: A Construction Industry Perspective*, CERF Report, December 14-16, 1994.

Mrs. MORELLA. I just wanted to point out: Remember back to the reauthorization, we picked the 6 out of 10 that said you should give priority to the laboratory functions, but we did not put into the language a real prohibition in terms of those other areas. But again we are looking at priorities.

Dr. PRABHAKAR. And then the appropriations language picked up some of that. They had some indications in their report language, as well, so if we ever get a budget we will find out what all that is.

Mr. TANNER. One last question.

The present law, as you know, limits federal funding for MEP Centers to six years. When an award is made, how do you all determine that the local centers will take into account this fact and plan for the termination of federal involvement?

Dr. PRABHAKAR. That factor is considered not just up front at the beginning but in fact throughout the activities of the center.

Let me back up and say that when this program began I think we had a very rudimentary understanding of what the federal role was in manufacturing extension.

What we have learned over the last few years is that what the Federal dollar is providing is the opportunity to reach the smallest manufacturers.

We have many centers, as they mature, that are very, very capable of being free-standing activities but we find that in order to continue their activities what they will stop doing is the work that reaches out to the smallest companies. They in essence will start looking more like the private consultants that do reach the mid-sized and larger manufacturers.

So first of all I think we have a much clearer understanding of what the Federal dollar does. As the centers have progressed, they are very aggressive and we are very aggressive working with them to think through what their strategy should be.

Again, I think successful centers—we do not worry about their financial ability to continue beyond the six years. But what we are losing, even in those instances, is the ability to reach the smallest companies. I think that is the key issue. That is the reason that the Administration has supported a lifting of the Sunset, while at the same time arguing that we should never have an entitlement program for centers, but we should in fact have a very vigorous attempt to make sure that at any moment in time we are only supporting the best activities, those that are continuing to deliver the greatest value.

So as long as the Sunset is in place, obviously we are going to have to live with that. That means that we will see some centers that continue but stop serving the smallest manufacturers in their regions.

Mr. TANNER. Thank you.

Mrs. MORELLA. Thank you, Mr. Tanner.

Mr. Calvert?

Mr. CALVERT. Thank you.

I want to also share in the remarks that were made earlier about Secretary Brown. We are all saddened by his death. My condolences to his family and those of you who worked with him.

Dr. PRABHAKAR. Thank you.

Mr. CALVERT. Earlier this year, Bob Walker, the Chairman of the Science Committee, sent a letter to Secretary Brown in regards to a GAO report which was just issued earlier this year regarding the Advanced Technology Program.

In the report, the GAO concluded that fully 50 percent of the grant applicants who were finalists for ATP awards were able to find funding in the private sector for their own projects.

But more troubling, 63 percent of the grant applications never even attempted to find outside financing; they went directly to the ATP Program.

So I would feel it would be impossible to assess the likelihood of success at finding funds if in fact they never went out to the private sector in the first place.

But to continue with that, I understand that even within the study that was commissioned by the Department of Commerce it refutes the claims that ATP focuses upon precompetitive technologies, for 62 percent of participants anticipate their company will commercialize a product or service, and more than 50 percent of the 1990 participants expect to earn revenue from ATP projects before the end of 1995.

That is in your own report.

Mr. Walker asked that the Department have an explanation for these contradictions. I was wondering if you were aware of this GAO report, and what comment do you have on that?

Dr. PRABHAKAR. Absolutely I am aware of that report, Mr. Calvert. If you do not have it, I would be glad to provide for you the response from the Department to that letter.

You raised three specific questions. Let me address each of those.

The first was that many applicants who were turned down in the ATP process found dollars elsewhere. If you go on to read the GAO report, they also report that, among those who felt that they could have done the work some other way, those who did get funding from other sources, with virtually no exceptions those companies did those projects at a much slower pace.

If you consider that the acceleration of only a few months in a technology development activity can make a difference between whether that technology is in this country or elsewhere, I believe that acceleration is critical, it is essential, and in fact it is a great deal of where the value in the program is.

So we need to be complete in the data, which do indicate that, even though work continued in those areas, it was not at the same pace.

The second question that you raised had to do with did companies seek funding from other sources before coming to ATP?

Of those that they questioned that did seek funding elsewhere, they had a very long trail of failures in finding the kind of resources to support the long-term, broad-based enabling research that is the focus of ATP.

It is not my view that we should require of companies that they age their technology before they can get resources from a program like this. I think they need to be able to move quickly.

When you ask companies about their history, their knowledge of the marketplace, their knowledge of capital availability, I believe you will find that they are very familiar with what it takes to get

money from venture capitalists, from within their own firm if they are in a larger company, and in each instance they have come to ATP because they are trying to do something that is beyond the reach of that time frame or that risk frame.

So I think we need again to look a little bit more deeply into that question.

Your final concern was that some of the technologies coming out of ATP were already getting commercialized. I am not going to apologize because we are beginning to see technologies enter the marketplace and make a difference in the economy.

That is actually quite explicitly the purpose. Our focus is on the enabling R&D that gets people over the barriers and lets them do the product development, the manufacturing, the distribution, the sales, what it really takes to make those technologies win in the marketplace.

But I think it is very much to the program's credit that some of the very earliest projects are now, after the federal funding is completed, are now getting the additional investment to see if they will live or die in the marketplace. I think that is actually quite appropriate.

Mr. CALVERT. I guess my question would be, of some of the technologies that have been developed, are they competing with existing technologies that did not receive ATP project funding?

Dr. PRABHAKAR. I think you will find—and let me just give you a couple of examples—that in most instances what is happening is that there is a new technical capability that is changing the rules of the game.

One of our early awardees is a company called astrom Biosciences. They came to ATP for help in developing a prototype process for taking stem cells from bone marrow and amplifying them, creating more of those cells in a bioreactor, a very aggressive technological prospect.

In the course of their ATP project, they made enough progress that today our project is completed and they have about $20 million now of private investment to go from that pilot stage to a real product.

They are about to begin clinical trials. If this technology works, it creates a whole new approach for bone marrow transplants, and one that is far less stressing for the patients who are involved.

What it competes with is a much more arduous, much more expensive, much more painful medical procedure. This is one example of many where I think technologies create whole new horizons, and it is not simply a matter of doing an old job in a slightly better way. It is a dramatic advancement.

Mr. CALVERT. I guess my comment would be, as you know I have been consistently making, whether or not the government is better at picking and choosing these industries rather than having a tax policy which is outside of our jurisdiction, of course, of investment tax credit, venture capital being more accessible to companies versus the government making a determination of whether it is a good project, which it may be, or a bad one.

With that, Madam Chairwoman, I am——

Dr. PRABHAKAR. Mr. Calvert, may I just respond on that? I would like to be very clear that we do not believe it is one or the other;

that we in fact believe quite strongly that you need as many of the policies, the tax and the regulatory policies, to encourage innovation as you possibly can have.

On the other hand, we need to recognize that, for example, the research and experimentation tax credits that we had in place for many, many years did provide a financial tool for companies. It did not in any way change the mix of R&D to go after the longer term and more enabling R&D.

So if you want to accomplish that job, it is not going to happen through tax credits. I think these are different tools, and they are all part of an economic strategy.

Mrs. MORELLA. I will recognize Ms. McCarthy, and then what we are going to do, Dr. Prabhakar, is there are going to be a series of votes. The first one will be 15 minutes, and then there will be a 5-minute one, and then probably another 5-minute one. So we will then, if it is okay with you, we will adjourn for about 20 minutes, or maybe a half hour maximum.

Dr. PRABHAKAR. That is fine.

Mrs. MORELLA. Do you want to start?

Ms. MCCARTHY. Do you want me to proceed with my question?

Mrs. MORELLA. Yes.

Ms. MCCARTHY. I will be brief.

I wanted to pick up on your comments with regard to the MEPs because I have one in my area, MamTech, in Overland Park, Kansas. While I am on the Missouri side, it does serve the greater Kansas City area—and very well—and it is slated for Sunset.

The impact will be that smaller businesses and manufacturers in our region will not be well served.

So my question is. What studies or data exist to support the claims that MEPs are in fact increasing their global competitiveness on the Nation's small- and medium-sized manufacturers?

And if that is positive data to support it, why would we want to eliminate help to these smaller manufacturers who still continue to need it?

Madam Chairwoman, I do not want to hold us up.

Mrs. MORELLA. If she does not have a chance to answer, we could come back and start off with that.

Ms. MCCARTHY. That is fine.

Mrs. MORELLA. I think you have an idea that you would like the whole subcommittee to hear the response.

Ms. MCCARTHY. I am happy to wait.

Mr. TANNER. Madam Chairwoman, could we leave the record open for those of us who maybe cannot come back to the hearing so we can submit questions for the record?

Mrs. MORELLA. Oh, absolutely. Absolutely. The subcommittee will be able to submit questions for the record.

We will be in recess for 30 minutes.

[Recess.]

Mrs. MORELLA. Well, since we have Ms. McCarthy here and Dr. Prabhakar, and Mr. Bachula is here, we will get started.

Do you mind reiterating your question, briefly?

Ms. MCCARTHY. I will be very grateful, Madam Chairwoman, to do that.

It basically was to pursue the notion of the Sunsetting that is going to go on for many of the MEP Centers, and the statement made earlier that the smallest manufacturers in a region will be dropped off the charts as far as help with regard to these Sunsets and changes.

I wanted to explore that, and the question I asked had to do with any studies that have been done, any documentation or data that reinforces the fact that the MEP Centers do make a difference and are cost effective, and how that could be utilized to keep these folks who really are in need, the smaller manufacturers, getting the assistance they need in the future.

And I know we are trying to balance our budget, and I am for that, but these are success stories and I hate to cut a success story.

Dr. PRABHAKAR. Thank you for the question.

Mrs. MORELLA. Could I add to the question, though?

Ms. MCCARTHY. Yes, please.

Mrs. MORELLA. Is there any way that any of these Centers could be made self-sufficient by charging?

Ms. MCCARTHY. That is a good point.

Dr. PRABHAKAR. That is in fact the key in their strategy as they move to become self-sufficient.

Let me back up.

Again, what the Federal dollars, and typically the state and local dollars, do is get these centers, give them the resources to go out and reach the smaller manufacturers.

When a manufacturing firm that has been getting expertise and information from the Center, you know, when they want to upgrade their capital equipment or when they want to rearrange their shop flow or when they want to do the new training for workers that they need, they do that on their own dollars. So again the tax dollars are only used to facilitate the access.

And again that comes back exactly to this issue of Sunset. What we fear will be lost as the Sunset kicks in is precisely the ability to reach those smallest firms. We think that this kind of consulting service will go on, but again just for the largest firms.

Ms. McCarthy, you had asked specifically about studies. Last year when I was here I reported to you some very early data that showed about an eight-fold impact for every Federal dollar spent.

So not only is this that the tax dollars are not being wasted, but in fact they are generating tremendous benefits in the economy. Just the fraction of that is captured in state and local taxes and federal taxes we believe in the long term is plenty to pay for the investment in the program with much left over beyond that.

More recently, there is a General Accounting Office study that was done looking at manufacturing extension. Some of the data from that are in my written testimony. A key result is that they talked to companies that had used the services of Extension Centers.

Those that had used at least 40 hours of those kinds of Extension services, 73 percent of those respondents said that they believed that assistance from the Extension Center had positively affected their overall business performance.

I know many of you have heard from small manufacturers around the country about the difference these services have made to them. My favorite story is the following.

When I was visiting a small manufacturer and he was going on at length about government procurement policies, regulatory policies, all these terrible things about the government, and I said, well, what about when you get assistance from this Manufacturing Technology Center?

And he said, they don't feel like the government. They help.

[Laughter.]

Dr. PRABHAKAR. So we are trying to change people's minds a little bit about that.

Ms. MCCARTHY. Madam Chairwoman, may I pursue just very briefly?

Mrs. MORELLA. Certainly.

Ms. MCCARTHY. Do the states support this program? And if so, how strongly?

Are there uncertainties at the state level now as we Sunset and discontinue Federal support?

Dr. PRABHAKAR. The support from the states has been very strong. This is a program that we simply could not do without the states because the approach here was to say we are not going to have a cookie-cutter, one-size-fits-all approach from Washington. We are going to go to the states and the local communities and the regions and build on what they know about how best to reach their small manufacturers and the needs that they have.

So we started out with a cost-shared program. The effect of our program in many instances has been to magnify and raise the level of the activity that was initiated on state dollars, but again the nature of this partnership is that states have made a commitment.

Their legislatures have stepped up to making the investment to work with us to make these Extension Services work.

The uncertainty from year to year and the funding in terms of rolling over centers that were begun with Technology Reinvestment Project funds, which is a key issue for our budget this year, and the continuing issue with the Sunset, all of those are factors that create greater uncertainty in their planning.

Ms. MCCARTHY. Thank you, Madam Chairwoman.

Mrs. MORELLA. Thank you, Ms. McCarthy.

Ms. Lofgren?

Ms. LOFGREN. Just quickly, because we have been through many of the issues on ATP last year, and we have reviewed all the reports, but I was wondering:

Every time I go home I make sure that I not only do office hours with my constituents in front of supermarkets, but I also visit high-tech companies and listen not only to CEOs but the directors of research in particular andfind out what they think is going on.

Last week in talking with people in several companies, the issue of ATP was raised again. Particularly in companies that have never received an ATP award but they are aware in the valley of the benefit of the program, even though their company might not have had a contract, that the research advance has really benefitted technology generally.

It was interesting that as I was getting that information feedback from people who do not have a direct financial interest in the program, that our local newspaper, The San Jose Mercury, came out with a report that "Silicon Valley Added 42,000 Jobs Just Last Year" and really, tech is driving the whole thing.

I am wondering. You know, there are many factors. I think clearly the Trade Agreement with Japan on chips was a factor, and others, so I do not want to say it is all the ATP program, but I am wondering. Is there a credible way to identify the job growth product from investments such as these? Have you done that in a way that would withstand scrutiny?

Dr. PRABHAKAR. I believe it would. I would be happy to share with you how we are approaching that job.

First of all, because our objectives are economic as opposed to most of the Federal investment which is focused on national security, basic research, et cetera, we explicitly go out and try to measure the economic impacts from the investments that we make.

Our Advanced Technology Program is still a very modest program compared to many of the other investments, and it is a very new program begun only in 1990. So you will find in your activities and in other parts of the country as well that there are many activities today in companies and small firms that started off with just one or two entrepreneurs and, as a consequence of their ATP activities, have grown and have attracted private capital.

Ms. LOFGREN. I can see those anecdotally and see the products——

Dr. PRABHAKAR. Absolutely.

Ms. LOFGREN. (continuing) —but do we——

Dr. PRABHAKAR. Absolutely. And I think the key point today is the stage we are at. I do not want to pretend to tell you that we can give you the full-blown economic impact of the ATP, because it is at least ten years from the inception of the first project before you are going to begin to see that. And today the program is really only six years old.

So I do believe we have the early data about job growth, about new opportunities for small companies, about new business alliances that are forming, and many of those stories are in this report that we released last summer.

As well, we are getting really close today to releasing a new report to Congress on the Advanced Technology Program that was requested in 1991 legislation. So we will have more data for you.

But I think the broader point is that if you look today at what is going on in the technology industry, it is impossible to ignore what is happening with the Internet and the World Wide Web.

Those activities in the commercial marketplace today, that explosion of activity, is building on a base of not a few years but literally 20 or more years of Federal investment from the Defense Department and the National Science Foundation to create what was originally the ARPA Net and then became the Internet.

That public investment was absolutely mandatory for the kind of new market evolution that we are seeing with the Internet and the World Wide Web.

On the other hand, that public investment would not have been very interesting economically if it were not for these private entrepreneurs, the venture capitalists, the larger companies diving in.

Now ATP did not exist at the time that those investments were made, but part of the reason this program was created was to recognize that we cannot only invest under the "national security" rubric and imagine that we are going to really capture the economic opportunities.

So I fully expect that in the future you will see that kind of explosive, new growth based on some of the seedlings we are planting today.

Ms. LOFGREN. Well, see, I think we are already seeing it and it is a matter of capturing in a credible manner the beginnings of the growth, assuming that we maintain our investment, because it is important to be able to quantify some of this to some extent.

Dr. PRABHAKAR. I absolutely agree with that.

Ms. LOFGREN. And especially, I am sure you have seen the Office of Technology Policy Analyses on Spending and Technology really suggesting that NSF has undercounted what Japan is spending in technology, and we are not competitive. I think that new information, which is chilling, really, to the country and certainly to high-tech industries and academic observers, needs to be brought into this whole discussion in a predictive mode.

One other thing that I would find interesting—and maybe you have already done this and just can send it to be off the shelf—but I mentioned in our hearings last year the Internet issue. I do not know what the Federal investment was in the beginnings of that.

It would be fun to see what we put up, and then to take a look at what is happening economic-wise vis-a-vis the Internet.

Dr. PRABHAKAR. I would be happy to send you that information. I think we have those data.

Ms. LOFGREN. Just a little example for folks.

Thank you, Madam Chairwoman.

[The following information was received for the record:]

The ARPANET and the NSFNET laid the groundwork for the current Internet. The ARPANET was aimed at basic networking capabilities for defense and defense-related programs and at defense technology. While it provided valuable tools and technology which were later used in creating the Internet, it was directed specifically towards defense issues and programs.

The National Science Foundation then provided a federal investment of a total of $210.9M from 1986 to 1995 in networking activities, including its NSFNET. The NSFNET was aimed at providing networking capability for universities and academic institutions to provide an open forum for the exchange of ideas and research.

Mrs. MORELLA. Thank you, Ms. Lofgren.

Mr. McHale, would you like to pose any questions to Dr. Prabhakar?

Mr. MCHALE. Thank you, Madam Chairwoman.

Dr. Prabhakar, of the 60 MEP Centers throughout the Nation, one of the most successful is located in my Congressional District at Lehigh University headed by E.D. Ritter.

I have worked very closely with that program over the years. We have received—I was just looking through the figures here—we have traditionally received about $1.6 million annually for Federal funding of that manufacturing resource center.

Anecdotally, I have a very high level of confidence that that center has made a real difference in terms of technology transfer of existing technology into the marketplace for rapid commercialization, and successful commercialization.

Do you have any—I guess following up on Representative Lofgren's questioning—do you have any standardized system for measuring the degree of commercial success that we have achieved through that technology transfer as implemented by the MEPs?

Dr. PRABHAKAR. Absolutely. One of the things that the National Manufacturing Extension Program is creating is in fact an evaluation system that tells us, for the tax dollars that are spent at the Federal level and the state and local level, what are we delivering back.

We have a set of tools that are being developed by some of the leading economists and economic groups working directly with the centers. Again, some of the earliest results indicate that we see about $8 worth of economic benefit flowing from every Federal dollar in the program, but we are evaluating that much more rigorously and following it over time.

Those data are based on companies' projections of how they will benefit. We need to now follow up and see if that is actually happening.

So we think there is a much more extensive job that needs to be done, and that is a component in our program.

Mr. MCHALE. I think there are really two elements there.

First is the objective quantitative measurement of success. Then, secondly, the communication of that success story once it has been properly measured.

Last year we had a close call in terms of future funding for MEP with the strong support of Congresswoman Morella and Sherwood Boehlert and some others in this committee. We fought successfully to keep that funding alive.

But there are those on the committee who in good faith have a different point of view, although I happen to disagree with their opinion, in seeking to terminate the funding. So to the extent that we can honest to goodness really measure how successful we have been in transferring that technology to achieve a commercial success, we need to be able to quantify that and present it clearly so that when we argue on behalf of the program we have hard numbers to back up our claim that MEP has been a success.

That cannot be a generic description of that success story. We need hard numbers in a clearly defined success story in order to justify the continued levels of Federal funding.

Last year we were fortunate to achieve continued funding. But for the intervention of Representative Morella, and Representative Boehlert, and some on our side of the aisle, we might have reached a different and unfortunate result. So I throw that out to you as a suggestion.

The second and final question I have is. Just as we have measured success in terms of commercialization domestically, do you have any data that would indicate that MEP has enabled small and medium-sized manufacturers to more effectively penetrate international markets?

And if so, would you comment on that?

Dr. PRABHAKAR. Yes, I would be happy to. I agree fully with your comments about the value of evaluation and will continue to provide those data to you.

We have many instances where Manufacturing Extension Centers have helped small manufacturers identify global opportunities—again, typically by linking them to the expertise that exists on that topic.

I am not aware that we have a comprehensive analysis on that particular topic since it is actually a fairly small component in the overall manufacturing services. But I would be happy to get you some examples of where that trade penetration issue has come up.

[The following information was received for the record:]

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PAGE 50, LINE 1125

The attached are case studies of small manufacturers who have been helped by NIST Manufacturing Extension Partnership Centers and who have shown improved foreign market penetration. A brief summary follows:

Clipper Diamond Tool Co, Inc. , Long Island City, New York: " The company exports15 to 20 percent of its products to Europe, South America, Israel, and Mexico and hopes to increase that number as well."

Coastal Technologies, Varnville, South Carolina: "The company's main product...will be supplied to a Japanese construction company building a geothermal power plant in Asia."

HJE Co. Inc, Watervliet, New York: "HJE is now a thriving business with sales in the United States, Europe, Asia and the Middle East."

NIST Industrial Impact

Company:

Clipper Diamond Tool Co. Inc.
Long Island City, New York

Business:

Manufacturer of precision superabrasive and diamond cutting tools and grinding wheels

Number of Employees:

38

The National Institute of Standards and Technology is an agency of the U.S. Department of Commerce's Technology Administration. NIST promotes U.S. economic growth by working with industry to develop and apply technology, measurements, and standards.

June 1994

Like the gem used in its product, the future once again looks bright and shiny for the Clipper Diamond Tool Co. Inc. This was not the case 3 years ago when company founder and president Joseph Klipper realized drastic moves were needed or the 50-year-old company would have to close its doors.

But after hooking up with the NIST New York Manufacturing Extension Partnership (MEP), the company has made a dramatic turnaround, improving productivity and morale and regaining customers.

When Klipper came to the United States from Belgium in 1940, he planned to set up a small manufacturing operation to provide gems for the jewelry industry. However, with America's growing involvement in World War II, he realized that both he and his newly adopted country could benefit if the company manufactured something more utilitarian than ornamental.

He turned his expertise to developing tools using industrial-grade diamonds to shape, size, and grind metal parts used for precision machining. During the war and for the next 40 years or so, business was good for the company. Sales were brisk, and the company counted among its customers numerous manufacturers such as Pratt & Whitney, Ford, and Chrysler.

But, during the 1980s things took a downturn. Rent for the Manhattan-based company was skyrocketing, and customers were turning to competitors in Japan and Germany.

"It's a story we hear quite a lot," says Phil Massaro, a field engineer with the New York MEP Industrial Technology Assistance Corp. (ITAC). "Mr. Klipper and others in the company recognized they were behind the times, that the company had stagnated, but they were not quite sure what steps to take to modernize."

After hooking up with the NIST New York Manufacturing Extension Partnership, the company has made a dramatic turnaround, improving productivity and morale and regaining

Massaro worked with Klipper, company vice-president Steve Grossman, and others to find a wide range of city and state grant programs to help the company upgrade and modernize its operations. Most of the grants were matched with company funds, says Massaro.

For example, he says, "We worked with them to access a program offered by New York City that will help offset costs of moving if a company relocates within the city." Moving to a new facility in Queens not only reduced rent costs but set the stage for the next step, a total reorganization.

With the expert advice of Les James, an engineering consultant hired with New York MEP's assistance, a new modern layout was designed and the company began to automate both its manufacturing and office operations. "For example, we installed computer-aided design and manufacturing equipment and an automated accounting and inventory control system. Clipper employees now can electronically transfer drawings directly to customers, and soon, customers will have direct access to other data, such as information concerning purchase orders and invoices," says James.

Also, with New York state grants facilitated by ITAC, James set up employee training programs in subjects such as statistical process control, quality management, and English-As-a-Second-Language.

"Our company has been revitalized," says Klipper. "We are once again able to compete both here in the United States and around the world."

The changes have resulted in marked improvements. For example, just 6 months after implementing a quality improvement program, Clipper earned Ford Motor Co.'s Q-101 rating—its highest quality ranking for vendors.

Statistics down the line look good: For 1992 and 1993, productivity was up 3 to 4 percent. Ninety-eight percent of all orders are sent out within 2 weeks, up from 90 percent. Cycle time for some products has been shortened to 7 days. Prior to the improvements, the shortest cycle time was 28 days. In addition, the number of orders leaving the factory on time has improved by 20 percent. The company currently exports 15 to 20 percent of its products to Europe, South America, Israel, and Mexico and hopes to increase that number as well. "The task before us now is to capture the opportunity for growth that the renewed market interest has offered," says Grossman.

"Our company has been revitalized," says Klipper. "We are once again able to compete both here in the United States and around the world. If it had not been for this help, Clipper Diamond Tool would not be around today," he says.

NIST Industrial Impact

Company:
Spartanburg Steel Products Inc.
Spartanburg, South Carolina

Business:
Manufacturer of stamped metal parts

Number of Employees:
600

Company:
Coastal Technologies Inc.
Varnville, South Carolina

Business:
Manufacturer of mist eliminators

Number of Employees:
15

The National Institute of Standards and Technology is an agency of the U.S. Department of Commerce's Technology Administration. NIST promotes U.S. economic growth by working with industry to develop and apply technology, measurements, and standards.

March 1994

Through the NIST Southeast Manufacturing Technology Center (MTC), manufacturers of products ranging from fishing rods and baseboard heaters to parts for cars and pressure vessels for geothermal power plants are taking advantage of computer-aided techniques that can speed product design and development.

One satisfied customer is the engineering department at Spartanburg Steel Products Inc., a South Carolina supplier of stamped automobile parts that employs about 600 people. With a technical assist from the Southeast MTC's Computer-Aided Design Laboratory, Spartanburg Steel successfully responded to a challenge by one of its major customers and thereby strengthened their relationship.

Specifically, Spartanburg Steel faced the task of developing a lighter, lower-cost alternative to the metal brace used to secure the dashboard to the frame of an automobile made by the customer. The company developed a new design, but, then, its engineers hit a snag: Because of the part's complex geometry, conventional, manual methods of stress analysis were not a practical, cost-effective option for determining whether the design would satisfy the load conditions and other structural-integrity requirements specified by the customer.

A possible solution emerged when Spartanburg Steel engineers attended a "CEO breakfast" on predictive engineering technology, which was arranged by the Greenville Technical College, an affiliate of the Columbia-based Southeast MTC. Recognizing that the technology might serve its needs, the company requested an in-depth seminar on a particular technique, known as finite-element analysis.

Presented with the challenge facing the company's engineers, senior specialists from the Southeast MTC proposed a computer-based approach that could be used to conduct the essential stress and weight analyses. Using the center's coordinate measuring machine, the specialists measured 10,000 different points on the surface of the part supplied by Spartanburg Steel. The digital data were used to create a graphic model, permitting reliable simulations of stress tests with the finite-element-analysis technique. The analysis of the new design revealed the distribution of stresses over the surface of the part.

With a technical assist from the Southeast MTC's Computer-Aided Design Laboratory, the company successfully responded to a challenge by one of its major customers.

The findings confirmed that a part based on the new design, which would reduce the weight of the brace by nearly a pound, would satisfy the customer's structural requirements.

Now in full production, the part is being used daily in a popular, high-volume vehicle.

Curtis Rhodes, one of the Southeast MTC specialists who worked with Spartanburg Steel, says that finite-element analysis is a valuable tool for evaluating designs. But, he adds, most small and medium-sized companies cannot justify investing in the technology and in training a staff member to apply it.

"Companies will have only an occasional need for finite-element analysis," Rhodes explains. "When you need the technology, it's more efficient to go outside the company and acquire this capability as a service."

Most small and medium-sized companies cannot justify investing in the technology and in training a staff member to apply it.

Rhodes and his colleagues have a steady stream of customers who are doing just that. For example, Coastal Technologies, of Varnville, S.C., recently used the Southeast MTC's service during the design phase of an ongoing project to build a 40-foot-tall pressure vessel, or cyclone separator, that will be packaged with one of Coastal's mist eliminators, the company's main product. When completed, the equipment will be supplied to a Japanese construction company building a geothermal power plant in Asia. It will be used to remove potentially destructive particles from underground steam that will drive the plant's turbines.

Harry Wechsler, president of the 15-employee firm, explains that, because of an unusual feature specified by the customer and unaddressed by engineering codes, Coastal was required to do a thorough mechanical analysis of the design. "We didn't have the resources—hardware, software, or expertise—but we knew the MTC did," he says, noting that Coastal has used the center's services on several occasions. "Our relationship with the MTC has been very beneficial. We make use of them whenever we think they can help us."

NIST Industrial Impact

Company:
HJE Co. Inc.
Watervliet, New York

Business:
Manufacturer of gas atomization systems and metal powders

Number of Employees:
4

The National Institute of Standards and Technology is an agency of the U.S. Department of Commerce's Technology Administration. NIST promotes U.S. economic growth by working with industry to develop and apply technology, measurements, and standards.

June 1994

As one of only four companies of its kind in the world, and the only one in the United States, HJE Co. Inc. is a big fish in a very, very small pond. And company president Joe Strauss likes it that way.

Strauss's company manufactures gas atomization systems specially designed to produce ultrafine metal powders from molten metal. These powders are used, for example, in solder and braze pastes and dental alloys. The particles also are used to coat base metal such as jet turbine blades. HJE also produces and sells the metal powders.

HJE is now a thriving business with sales in the United States, Europe, Asia, and the Middle East. But it started almost as a hobby, says Strauss, and may not have developed at all without some assistance from the NIST New York Manufacturing Extension Partnership (MEP).

A materials engineer with a Ph.D. from Rensselaer Polytechnic Institute, Strauss first seriously considered the gas atomization technology as a money-making venture after attending a seminar in 1987 and realizing that no one was commercializing it. "Many people, including myself, were interested in the 'gee whiz' aspect of turning liquid metal into a powder as fine as talcum powder. But very few people were manufacturing equipment that could do this or exploring ways to use the powder," says Strauss.

Although still a student at the time, the idea stuck and eventually Strauss started designing equipment to produce very fine powder. In particular, he had an idea for a special nozzle design that can handle high temperatures and a very reliable control system.

But he was having difficulty translating what was in his head to mechanical drawings that could be understood by a parts manufacturer. "I was spending lots of time, money, and energy and still not getting it quite right," he says.

What he found was a gold mine of manufacturing equipment, ideas, and expertise.

After struggling for several months, he eventually heard about the NIST New York MEP. "I wasn't quite sure what they had to offer and, to be honest, if I had found a good drafting shop along the way I probably never would have made it to their door," says Strauss.

But he did, and what he found was a gold mine of manufacturing equipment, ideas, and expertise. "I was like a kid in a candy store," says Strauss.

The NIST New York MEP and its Manufacturing Technology Resource Facility (MTRF) provided Strauss the opportunity to learn about modern manufacturing technology, explore "hands-on" a variety of computer-aided design and manufacturing equipment and software, and get tips from experts. "When Joe first came to us he had lots of good ideas and some sketches and rough drawings," says Sam

Chiappone, manager of the MTRF. "But he did not have the basic set of blueprints that he needed to get parts machined," he says.

Chiappone and others at the MTRF did more than help Strauss figure out how to design the equipment he needed. "They also made sure that what I was designing was practical to manufacture and helped me find machine shops to make the parts," says Strauss.

Strauss spent about 6 months at the MTRF and eventually purchased his own computer-aided design and manufacturing equipment and software. "The people at the MTRF were extremely helpful and patient," he says. "With the information I gained I was able to dramatically streamline my operations and improve the quality of my product as well."

"The people at the MTRF were extremely helpful and patient," he says. "With the information I gained I was able to dramatically streamline my operations and improve the quality of my product as well."

Strauss still occasionally seeks some guidance and vice versa. "They often call on me when they need a materials expert," says Strauss.

Today, Strauss is looking for a larger facility and is trying to market his gas atomization technique to a new industry—jewelry manufacturing. "They are not comfortable, yet, using a powder to make jewelry, but I'm working on it," says Strauss. And, if he does decide to jump into a larger pond and needs some assistance, he knows he can turn to the NIST New York Manufacturing Extension Partnership.

Mr. McHALE. I come out of a military background where one of the more commonly known expressions, or truisms, is that amateurs talk tactics and professionals talk logistics. In the battle on behalf of NIST, ATP/MEP, we need some logistical support.

You need to give us some ammunition so that when other members of the committee—again in good faith but I think with misguided judgment—attack these programs as being commercially ineffective, we are depending upon you for the logistics of our argument and the ammunition behind our argument to establish that these are programs where the investment is well and wisely made.

So I ask you to provide that information to me in a timely manner, and to the other Members of the Committee so that we can approach these funding questions with a better understanding of just how successful these programs have been.

Thank you, Madam Chairwoman.

Mrs. MORELLA. Thank you, Mr. McHale, and for your kind words.

I wanted to ask a question dealing with the Technology Administration. The Technology Administration has requested $2.5 million for the U.S.-Israel Science and Technology Grant Fund.

This is the second year of a three-year commitment for $5 million each year, which will go on through 1998.

I wondered if you might discuss where this funding came from last year when this was one of the issues, and where the $2.5 million is coming from for Fiscal Year 1997.

And then I wondered if you might talk about the goals and the missions of the program. Maybe Mr. Bachula would also like to comment.

I wanted to give him a chance to say something; you know that. [Laughter.]

Dr. PRABHAKAR. I will let Gary begin. I do not have anything to add on that one.

Mrs. MORELLA. Okay.

STATEMENT OF MR. GARY BACHULA

Mr. BACHULA. Madam Chairwoman, since the overall budget we are discussing here today is 99 percent NIST, it is quite appropriate that Dr. Prabhakar do most of the talking.

On the U.S.-Israel Science and Technology Commission, as you know the agreement with Israel was for a $15 million U.S. Government contribution matched by an equal amount from Israel, matched in turn then by the private sector contributions to the projects over a three-year period.

The funding for last year involves some transfer funds from within the Department of Commerce. And there is still pending, if the Fiscal Year 1996 budget is ever resolved, the additional fundings.

There is a White House request. Whether or not the Congress acts favorably upon that I guess we are not yet certain, but that would be the additional money for Fiscal Year 1996.

In Fiscal Year 1997 because of the budget constraints, OMB approved only $2.5 million in our Department of Commerce request as the next increment in this.

We are not certain whether there would be additional monies transferred or available from other agencies.

In the past it has come from agencies, including the Defense Department.

Mrs. MORELLA. Maybe the $2.5 million could come from State instead of the Technology Administration.

Do you want to comment on the mission, Dr. Prabhakar?

Dr. PRABHAKAR. Well the only thing I would like to add to what Gary said, he specified that the funds did come from Commerce.

There was quite some negotiation back and forth, including with the Congress, about where those funds would come from.

They ultimately came out of an account from the International Trade Administration and not from within the Technology Administration.

Mr. BACHULA. We just basically believe that this program obviously has a dual purpose.

One is to strengthen the economies of both the United States and Israel through collaboration on high-tech projects that can benefit both of us; but also to strengthen the peace efforts in the Mideast in a way that has security benefits to this country as well as to the Mideast.

This has been a small program and a small project that has been successful to date, and we hope that Congress will look favorably on it in the future.

Mrs. MORELLA. Yes. It seems to me that in facing the reality of it, that really it is a peace kind of project and not like emerging technologies that are going to help us become far more competitive, which is why maybe it is appropriate that we look for other departments and agencies to do that kind of continued funding for that particular commitment.

Mr. BACHULA. Unfortunately, as you know, Madam Chairwoman, the State Department's budget falls under the same appropriations subcommittee as we do.

Mrs. MORELLA. I know.

Mr. BACHULA. So at least one part of the Congress looks at this as the same pot of money.

Mrs. MORELLA. You are right.

You know, it is interesting with the 13 appropriations bills, and I think my colleagues would agree, you just get so many things tucked into each one of those appropriations bills that it is very hard to divide as you are making your evaluations.

Mr. Tanner, would you like to pose any questions?

Mr. TANNER. No, Madam Chairwoman. I would like to thank you again for holding this hearing. I think it is very timely.

Mrs. MORELLA. Ms. Lofgren?

Ms. LOFGREN. Just a real quick question.

I was wondering if you could go into—I understand there are going to be some changes—the focused versus general ATP competition and how that will work, and what the differences are?

Dr. PRABHAKAR. I would be happy to tell you about that.

When I came into this job as part of the new Clinton Administration in 1993, ATP had been underway for a few years and had established competitive processes and industry-driven priorities and the basic tenets of the operation. But at that point it was a very small pilot-scale program.

It had only general competitions. One general competition open all areas of technology every year.

It became clear that, as part of our scale-up strategy, to have the kind of major impact that we hoped for a program like this that we needed a way to focus investment, to have investments in strategic areas still defined by the industry but investments where we could have a collection of projects working on different aspects of a problem.

Weaving together the way I think anyone thinks about investment is, if you think about it, in a strategic way you will always look for critical mass, and that is really what we were trying to do.

In October of 1993 we launched a process in which we asked industry and the broader technical community not just for their ideas about individual projects to do, but this time we said tell us about the big strategic opportunities. What are the investments that will make a major difference for the economy where the broad enabling technologies need to be done in this partnership arrangement.

We got about 1000 white papers from people around the country, a fabulous response. About, I think a total of about 300 of those papers ultimately wove into the 11 focus programs that we have been able to launch.

They cover areas from information infrastructure for health care to manufacturing composite structures, to digital video information networks, around all the technology arenas, but a very sharply focused investment that really I think is creating critical mass in those areas.

We continue to have a general competition every year because we want to make sure we have the door open for ideas that are not in one of those focused areas.

Our hope had been to continue to build the number of focus programs, and then to ultimately get to a steady state in which every year 20 percent of those programs would be ending a new batch could be begun. We have been stalled this last year, obviously. But, meanwhile, the progress that has been made, especially in the first few focus programs that were launched about two years ago now, we are beginning to see some dramatic progress.

If you look at the DNA diagnostics community, at every major meeting you go to in that area you will find that there is a session on miniaturization technology. It is all ATP-awardees.

There is a whole thrust now in that area that is going to drop the cost and the time for DNA diagnostic procedures that ATP is really fueling, and there are similar examples in some of the other areas.

Ms. LOFGREN. What are some of the other examples?

Dr. PRABHAKAR. Another one is "manufacturing composite structures."

Here our goal was to bridge between the laboratory capability to build polymer composites that had tremendous structural capabilities at low weight. Everyone in the lab said, gee, isn't this great! People who are actually manufacturing automobiles, or roads, or bridges said that's sort of nice, but what about manufacturing costs? What about reliability? What about corrosion? What about safety?

Addressing those key issues to bridge between the laboratory and the ultimate user was the core of our program. Today I think we are much closer, and in fact are on the threshold of seeing widespread use of composite structures in automobiles to reduce the weight and maintain the safety and the structural integrity of cars.

That creates a dramatic new set of opportunities in the manufacturing process. It changes the tools that are required, the materials that are used, the way factories are configured; it is a very broad-reaching effect from that program. And I would be happy to go on for hours.

Ms. LOFGREN. Thank you.

Mrs. MORELLA. Well, we have kept you here for longer than we even thought and we very much appreciate you coming for this I think very important re-authorization meeting.

Thank you. We have several others coming up, as you know. I think the next one is like April 30th.

Thank you very much, Dr. Prabhakar.

Dr. PRABHAKAR. Thank you.

Mrs. MORELLA. Thank you very much also for being with us. Any other questions will be submitted to you, and I do remind the subcommittee members of that.

Mrs. MORELLA. Thank you. The meeting is now adjourned.

[Whereupon, at 3:45 p.m., Tuesday, April 16, 1996, the hearing was adjourned.]

[The following material was received for the record:]

Statement of Dr. Robert J. Hermann
Chairman, Visiting Committee on Advanced Technology
of the National Institute of Standards and Technology
before the
Subcommittee on Technology
Committee on Science
U.S. House of Representatives

April 16, 1996

Madame Chairwoman and Members of the Subcommittee; I am pleased to have the opportunity to speak at your oversight review of the research laboratory programs of the National Institute of Standards and Technology.

I am the Chairman of the Visiting Committee on Advanced Technology, of the National Institute of Standards and Technology (NIST). This advisory committee, established by the Omnibus Trade and Competitiveness Act of 1988, regularly reviews the policies, programs, and budget of the Institute. This committee has nine members, soon to be increased to fifteen members, selected from the private sector.

I am also Senior Vice President, Science and Technology, at United Technologies Corporation. In this position, I am responsible for assuring the development of the company's technical resources and the full exploitation of science and technology by the corporation.

In addition, I am involved in other activities which may be of interest to the subcommittee. I am a member of the President's Foreign Intelligence Advisory Board and the Commission on Missions and Capabilities for Intelligence; the Defense Science Board; the National Academy of Engineering; the National Research Council Commission on Physical Sciences, Mathematics and Applications; and the National Society of Professional Engineers Industry Advisory Group. I am also a member of the Board of Directors for Draper Laboratories and the American National Standards Institute (ANSI) as well as the Board of Trustees for the Hartford Graduate Center.

Let me begin by saying that I have become a strong supporter of NIST and its programs. Less than four years ago I had essentially no contact with this Institute and my professional experience was only tangentially related to its activities. In the last few years, I have had the opportunity to see it in action from the Visiting Committee perspective and to understand much better its essential role in our society. I have also broadened my standards-related experience by joining the Board of Directors of the American National Standards Institute and serving on the National Research Council's Commission on Physical Sciences, Mathematics and Applications. This Commission has oversight responsibility for the Board on Assessment of NIST Programs which provides a comprehensive review of the NIST Laboratories. I now feel that I have a much better perspective on which to base my judgments.

Before addressing the principal topic of this hearing, the NIST laboratory programs, I wish to say a few words about the extramural programs of NIST, that is, the Advanced Technology Program (ATP), the Manufacturing Extension Partnership (MEP), and the Baldrige National Quality Program. In my view these are sound programs, are contributing to the economic health of our nation, and are a wise use of the taxpayers' money. Our 1995 annual report, which I submit as an attachment to my statement, gives more information about the Committee's evaluation of these programs, as well as our evaluation of the NIST laboratory programs.

The Advanced Technology Program (ATP)

The Advanced Technology Program (ATP) invests directly in the nation's economic growth by working with U.S. industry to develop high-risk, enabling technologies that, if successful, can lead to advanced products, manufacturing processes, and services with potentially large economic benefits to the nation. Companies prepare the technology development proposals, cost share, and demonstrate a commitment to downstream commercialization. The ATP does not fund product development, although a number of "spin-off" products have already resulted from ATP-funded projects. Companies funded by the ATP assert that they have been helped to accelerate technology development and commercialization by funding high-risk research and development that would not have been done otherwise, or would have been done too late or with too narrow a scope to capture the appropriate market. The ATP has also clearly catalyzed the formation of consortia among companies, and also among companies, universities, and government laboratories which were unlikely to have occurred without the ATP. About half of the awards to date have been made to small businesses, and many small businesses are involved in the awards to larger companies.

The Manufacturing Extension Partnership (MEP)

The Manufacturing Extension Partnership (MEP) assists the nation's smaller manufacturers through locally-run Manufacturing Extension Centers. These Centers help with the adoption of modern manufacturing processes, business practices, and appropriate technologies and techniques. The Centers are industry driven, are selected by a rigorous, merit-based process, and are cost-shared with state and local governments. With the announcement of 18 new awards in 1995, the MEP has now grown to be a truly national manufacturing support program with 60 Manufacturing Extension Center awards. Together with over 240 field offices in 42 states, this national system now provides access to manufacturing extension services for nearly four-fifths of the country's small manufacturers. Studies of Center projects show a high leveraging of private investment and significant benefits to the small manufacturers.

The Malcolm Baldrige National Quality Award Program

The Malcolm Baldrige National Quality Award has increased enormously the understanding and application of quality principles in this country. Since 1988, 24 companies have won the Baldrige Award. It is perhaps more important that over one million copies of the award criteria have been distributed. Award winners have shared information on their quality improvement strategies and results with hundreds of thousands of companies, educational institutions, government agencies, health care agencies, and others. The award has thus had an impact which reaches far beyond the award winners. During the past year, pilot programs were carried out in education and health care. There was an enormous response. Over 20,000 copies of the award criteria were requested, and 46 health care and 19 education applications were submitted. The Committee feels that it would be worthwhile to consider establishing health care and education awards modeled on the Baldrige program. However, federal funding to support them is not included in the 1996 budget or in the proposed 1997 budget. We support NIST's efforts to establish private-sector funding for these awards.

Science and Engineering Research

I would now like to turn to the principal subject of this hearing, the NIST laboratory programs. Let me begin by asserting that I believe our country must have a competent, science-based, trustworthy, and easily accessible measurement infrastructure. Without it, we cannot have the interoperability of materials in industry, the ability to communicate with ease and authority about industrial matters, and the leading-edge, national competitive advantages in new technologies and industries.

An absolutely essential element of that infrastructure is the metrology laboratory system of NIST. The NIST laboratories provide the science and engineering basis for the physical standards upon which the entire measurement infrastructure of the United States depends. No other institution – public or private – performs this function for the United States. The industrial sector clearly understands that this must be a centrally executed responsibility, performed competently and fairly for all of industry.

The laboratory programs of NIST are conceived and rationalized to support this standards mission. They are not there to perform science for the sake of science, even though good science is often a by-product of their work. NIST is a mission agency with a key role in the operating industrial activities of the nation.

These programs are also not conceived to augment the science and technology base of the private industrial sector even though their efforts often do support the private industrial sector. Close cooperation between NIST and industry is extremely important. In order to make the measurement science base accessible to industry and for NIST to understand the measurement science base that will be needed by industry in the future, NIST must have an extensive program of outreach and cooperation with the scientists

and engineers of the private sector. You will find, therefore, a great variety of mechanisms being used to assure that the investment being made in the NIST laboratories can be exploited by industry. There are many visiting scientists and engineers from industry working with NIST scientists and engineers. There are cooperative programs with individual companies and consortia. NIST also holds many workshops for industry on special topics. This set of relationships is sound, worthy of our pride, and is a comparative advantage for our industry.

NIST's laboratories do world-class research, but their strong ties to industrial technology assure that they will apply their strengths to real-world problems. They provide the kind of infrastructural technology that America's companies need to develop, evaluate, and certify the performance of new, high technology products. They have an enormous job to do, and industry is constantly calling on them to do more.

The NIST Director, Dr. Arati Prabhakar, is a strong supporter of the laboratories and their standards and measurement mission. She knows, as do we, that the laboratories are playing catch-up after years of inadequate budgets for both research programs and for facilities. The technical initiatives of the laboratories are timely and address key national technology needs. The restoration of NIST's research facilities to world-class condition is long overdue. We give these items a very high budget priority for Fiscal Years 1996 and 1997 and we urge you to do the same.

We support the NIST strategy of using its increased laboratory funding to emphasize quality and mission focus rather than staff growth. Replacement of present contract research will allow NIST to take greater control over its research agenda and sharpen its focus on support to industry.

NIST has announced plans to form a new Information Technology Laboratory. We believe that this can strengthen NIST's ability to support interoperability and standards in an area vital to the United States.

It is important to note that the laboratories created and propagated the technical culture and commitment to excellence that drive all of NIST's programs. They are the reason that the Advanced Technology Program, the Manufacturing Extension Partnership, and the Malcolm Baldrige National Quality Program were put at NIST in the first place. I cannot say this too strongly: the laboratories are the core of NIST, and their vitality is essential to its success.

I have attached some written materials from NIST which give a variety of examples of the ways that NIST laboratories provide value and essential functions to our industry and our consumers. Because the number of ways and examples are so many and so varied, I have found it difficult to simplify the description of this important function. These lists of examples have been useful for me; perhaps you will find them useful as well.

Standards in Trade

In addition to being the science- and engineering-based authority for standards, the NIST laboratories performs other important functions for the country. Because it is regularly and routinely involved in the discipline and process of standards and thus has relationships with industry, other elements of the U.S. government, and with foreign governmental agencies concerned with standards, NIST has become an essential part of non-physical treaty standards and of the U.S. voluntary standards and conformity assessments system.

Some of us on the committee are a part of the nation's voluntary standards system through participation in ANSI. ANSI is the lead organization of the federation of activities that constitute the U.S. voluntary standards system. Recently ANSI and NIST signed a Memorandum of Understanding to formalize and facilitate cooperation between the government and the private sector in standards and conformity assessment activities. I want to particularly note that the impetus for this initiative was from the industrial members of the ANSI Board of Directors. They realize that the competitiveness of our nation demands that on some matters we, as a society, must act together. Dealing with standards, the standardization process, and conformity to those standards and processes is something that we must do in this globally competitive world and that no company or industry can do by itself. We can do most of the work in the private sector and that is the style of the voluntary standards system, but not all countries behave as we do. We in industry often need the help of government when we cross sovereign borders. Whether it is the U.S. Trade Representative, the Department of Commerce, or NIST in the standards field, to deal with other sovereign nations sometimes requires U.S. government and U.S. industry cooperation. We must then know how to cooperate effectively and anticipate the times and circumstances when that cooperation will be needed.

After years of wasteful squabbling on the part of both the public and private sector, we have now made significant progress in understanding, communications and mechanisms for cooperation in the voluntary standards community. Industry sees a strong role for NIST in this partnership.

The Future

In summary, NIST's programs are carrying out important work, have been well-managed, and have performed superbly. NIST has demonstrated that it can scale up its programs quickly, while maintaining their quality and effectiveness. This has been particularly noteworthy in the Advanced Technology Program, which has gone from one general competition per year to one general competition plus eleven focused program competitions in FY 1995; in the Manufacturing Extension Partnership, which has grown from seven manufacturing extension centers in 1993 to 60 centers early in Fiscal Year 1996, and in the Baldrige National Quality Award Program, which has demonstrated that it can apply industrial quality principles to health care and education.

Much of NIST's strategic effort this year has concerned the measurement and assessment of effectiveness in each of its four major program areas, that is, the impact on customers in industry and elsewhere. A report was issued by NIST in May 1995, "Delivering Results – A Progress Report from the National Institute of Standards and Technology," which discusses how NIST is addressing these issues. An updated report, "NIST Industrial Impacts – A Sampling of Successful Partnerships," was issued in January 1996. The operational aim is to focus and leverage Federal expenditures so that relatively small investments yield meaningful economic benefits for the nation. We believe that this is a sound and essential approach during a time of constrained Federal budgets and growing economic competition.

Measuring the impact of results is not easy. The impacts of NIST's programs are at times quite direct and readily measurable. Often, however, the impacts are diffuse, and the beneficiaries may not even appreciate, let alone be able to evaluate, the extent of NIST's contribution. We believe that NIST should be commended for addressing these very difficult questions. Our 1995 report describes some of the very encouraging results.

In conclusion, we are confident that NIST is ready to use its 1996 and 1997 budget increases effectively. The laboratories are ready with technical initiatives that address key national needs. The ATP has demonstrated its ability to plan and execute focused programs that will accelerate progress in key technologies. The MEP is well along in building a comprehensive, national manufacturing support network that we believe will be a major national asset. The Baldrige program will continue its work with industry while taking the quality message to the education and health care communities. Across the board, NIST has demonstrated that it can deliver.

Furthermore, NIST has the full backing of the Department of Commerce. The Department has worked very hard to provide NIST with the resources it needs, and deserves the thanks of those in the industrial and technical communities who view the President's 1996 and 1997 budgets for NIST as very good signs. The late Secretary Brown made this commitment very clear when I met with him late in February to present the Visiting Committee's annual report.

The budget before you will accelerate programs with proven effectiveness – programs that owe a great deal to your committee, and that, we believe, merit your support.

That concludes my statement. Thank you for the opportunity to present the Visiting Committee's views. I will be happy to answer any questions that you may have.

Attachments:

1) How America Counts on NIST for Measurements: Important Facts
2) NIST Laboratory Program: Services and Benefits
3) Standards, Measurement, and the NIST Laboratories: Don't Leave your Economy without Them

U.S. Department of Commerce/Technology Administration
National Institute of Standards and Technology

HOW AMERICA COUNTS ON NIST FOR MEASUREMENTS: IMPORTANT FACTS

Created in 1901 out of economic necessity that has grown over time, the Commerce Department's National Institute of Standards and Technology is the nation's premier institution devoted to the science and practice of measurement. The agency's laboratories are a key part of NIST's portfolio of four technology programs. The laboratories develop and supply companies, universities, hospitals, and other organizations with essential measurement know-how. They develop otherwise unattainable tools that ensure confidence in the growing number of measurements demanded by the technically complex affairs of commerce, science, engineering, health, safety, defense, law enforcement, and the environment. "NIST quality" measurements are part of a universal technical language linking U.S. companies and institutions to the rest of the global economy.

NIST measurements are vital to the functioning of the entire economy, helping to ensure fairness and efficiency in the sale of more than $2 trillion worth of goods and services.

- Accurate and uniform measurements of weight, size, volume, and other quantities maximize efficiency and promote customer confidence in the sale of goods ranging from lunch meat at the deli counter to natural gas flowing through transnational pipelines to ultrapure gases purchased by semiconductor manufacturers. The consequences of weakening the underpinnings of the national measurement system are mistrust, disputes, and costly inefficiencies at every one of the many steps leading from raw inputs to finished goods and services.

NIST tools and services are the ultimate references for the hundreds of millions of measurements made daily by U.S. companies, small and large.

- More than 350 different NIST-developed measurement tools and services are embedded into the quality control systems of the automotive industry—from small suppliers of metal parts to large refiners of gas and oil. Virtually all U.S. semiconductor manufacturers depend on NIST-developed test methods to evaluate their raw materials, processes, and products. The entire U.S. steel industry relies on more than 125 NIST Standard Reference Materials in assessing the quality of raw materials and finished products.

The top tier in the nation's measurement chain, NIST conducts research that anticipates long-term needs in basic science and engineering and responds to industry's continual demands for increased accuracy.

- NIST aims to develop measurement capabilities that are four to 10 times more accurate than the best quality-inspection methods practiced in industry. The chain of precision measurements leading to the factory floor begins at NIST. At each step along the chain—from NIST to private calibration lab or precision equipment maker, to company standards lab, all the way down to the production cell—uncertainty is introduced, necessitating the high (often, world best) levels of accuracy achieved by the agency.

- Long-term efforts have paid off with NIST's newly developed Molecular Measuring Machine, a unique atomic imaging microscope with a field of view 250,000 times greater than that of current microscopes. It will provide crucial measurement support to industry and university researchers studying ways to manipulate nature's molecular architecture for practical purposes, from creating entirely new materials to manufacturing future generations of integrated circuits.

NIST measurements, services, and expertise underpin efforts to eliminate technical barriers to trade, which could boost annual U.S. exports by $20 billion or more.

- Measurement traceability to NIST, internationally recognized as the U.S. measurement authority, enables U.S. companies to demonstrate compliance with spe-cific technical standards, an increasingly common prerequisite for doing business in foreign markets. Without NIST, many firms would be shut out of those markets or forced to acquire measurement services from foreign laboratories, causing delays and imposing costs ultimately borne by the U.S. economy.

"NIST quality" measurements are crucial to the performance of U.S. military equipment systems.

- The Defense Department relies heavily on NIST measurement expertise and standards, specifying that systems and components be calibrated with equipment and methods traceable to NIST.

- NIST developed specialized equipment that the U.S. military uses to calibrate—and thereby ensure the accuracy of—range-finder and target-acquisition systems deployed on jets, helicopters, and missiles.

NIST measurement research and its impartial expertise are national resources, tapped regularly to address health, safety, and environmental issues.

- NIST measurements were instrumental in identifying automobile exhaust as a major environmental source of lead in children. NIST research has yielded reliable, widely adopted methods for measuring electric and magnetic fields from power systems, essential to resolving the issue of whether exposure to the invisible fields poses health risks. NIST measurement references are used to ensure that radiation doses are administered accurately, safely, and effectively in 7 million diagnostic and therapeutic procedures performed each year.

NIST-developed measurement methods help companies transform new technologies into manufacturable products, while furthering the aims of university scientists.

- Laboratory-developed, one-of-a-kind measurement equipment is a resource for the entire research community. For example, NIST scientists helped their counterparts at Carnegie Mellon, MIT, the University of Minnesota, and other institutions install and apply NIST-invented technology for studying the magnetic structure of materials in unprecedented detail. In industry, companies racing to develop new high-density information storage systems—firms ranging from tiny Nonvolatile Electronics, Plymouth, Minn., to the Digital Equipment Corp.—have collaborated with NIST on research made possible by the unique magnetic microscope.

U.S. Department of Commerce/Technology Administration
National Institute of Standards and Technology

NIST LABORATORY PROGRAM: SERVICES AND BENEFITS

The Commerce Department's National Institute of Standards and Technology (NIST) provides the nation with unique research and services in measurement and standards matters that help industry, consumers, and the scientific community and contribute to improved public health and safety, law enforcement, and national defense. Among other roles, NIST acts as the nation's measurement laboratory—serving as a neutral third party in ways that could not be duplicated by private organizations. Examples of NIST services and benefits follow.

Industry

Higher quality products, more reliable and more flexible processes, fewer rejected parts, speedier product development, more efficient market transactions, higher levels of interoperability among machines, factories, and companies. These are some of the practical advantages that U.S. companies realize from the NIST laboratories' research, services, and standards-related activities. The ultimate U.S. reference point for measurements with counterpart organizations throughout the world, the laboratories provide companies, entire industries, and the whole science and technology community with the equivalent of a common language needed in nearly every stage of technical activity.

- Without NIST, electrical utilities and consumers would have no reliable source for accurate calibrations of watthour meters that serve 100 million homes and buildings and track nearly $200 billion of electricity. A measurement error of just 1 percent translates into costs totaling almost $2 billion, borne by consumers or utilities.

- Gas producers, distributors, processors, and consumers save about $150 million annually from NIST research and measurement methods that improve accuracy in natural gas pipeline metering.

- Electric power grids, communications networks, banking systems, and satellite and guided missile navigation systems rely on NIST's super-accurate atomic clock for time and frequency signals. Los Angeles County, for example, saves an esti-mated 22 million gallons of gasoline per year and 55,000 hours of driving time each day by synchronizing traffic lights with NIST's time and frequency services.

- Entire industries rely heavily on NIST's Standard Reference Materials for accuracy and quality assurance. The steel industry relies on over 125 different NIST measurement standards for reliability of raw materials and finished steel components that go into bridges, buildings, and other structures.

- U.S. producers and users of optical fibers depended on NIST to develop the technical foundation for more than 20 voluntary measurement standards credited with accelerating the growth of the optical fiber market and communications networks.

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■ The U.S. automotive industry relies on more than 350 different NIST-developed measurement tools and services for quality control systems—everything from purity of glass and steel to reliability of fuel, highway cement, and exhaust systems.

■ Semiconductor manufacturing equipment companies have counted on NIST measurement research and tools to drive down the size and drive up the performance of their products—enabling improvements by the makers and users of integrated circuits. Industry estimated that just one NIST project—which could not be undertaken by any single company—saved industry over $30 million, a return of more than 100 times the cost of the work.

■ U.S. engineers in aerospace, automotive, and other industries trying to take advantage of computer-aided manufacturing technologies are benefiting from NIST's management of a 26-nation effort leading to an important new data-exchange standard. In the automotive industry alone, costs due to incompatible systems are estimated to approach $100 million.

■ U.S. semiconductor manufacturers attributed 4 percent of their productivity growth over a five-year period and annual savings of up to $500 million to NIST research.

■ American companies could gain between $20 billion and $40 billion worth of exports if NIST succeeds in its efforts to help eliminate non-tariff-related barriers to trade such as restrictive standards and testing requirements imposed by other nations.

■ The nuclear energy industry and the public depend on measurement standards developed by NIST that are essential for continued safe operation of 109 power plants. NIST develops and updates industry testing procedures and advises the Nuclear Regulatory Commission on judging the strength of reactor pressure vessels, a task that requires special measurement expertise and impartiality.

■ The aircraft industry and public rely on unique NIST facilities and expertise needed to understand metal failures such as those that caused the top of an Aloha Airlines passenger jet to rip off in flight. In similar work, NIST materials and construction expertise helped explain why an oil storage tank released 4 million gallons of oil into a Pennsylvania river, shutting down drinking water for Pittsburgh and other cities; NIST recommendations for tougher safety standards were quickly adopted by the industry.

■ NIST created the world's most accurate instrument to measure layers on silicon chips at thicknesses the semiconductor industry demands for precise manufacturing control. The Semiconductor Industry Association noted, "NIST is the only place in the U.S. where the broad range of measurements needed for semiconductor processing are routinely and systematically developed."

■ NIST helped telecommunications companies to synchronize their transmissions to provide their users error-free connections. "By my calculation, NIST saved us almost one year in the time it took to develop the proper synchronization standard," says Rodney J. Boehm, chairman of a subcommittee of the telecommunications indus-

try's Exchange Carriers Association. "It is imperative that NIST con-tinue to be involved to help guide us and ensure that we use [NIST] expertise to speed up the standards process for the good of the entire industry," Boehm adds.

■ Virtually the entire space-based communications industry has adopted NIST-developed methods to test microwave antennas, saving companies millions of dollars. One company estimates it has saved $35 million by implementing the NIST near-field techniques. NIST-developed techniques for trouble-shooting and repairing complex antenna arrays also have produced substantial savings. McClellan Air Force Base in California was able to reduce repair time from as much as a year to "only a few weeks" as a result of NIST assistance.

■ Manufacturers of electronic products or products with numerous electronic components use commercial versions of a NIST-developed TEM cell to check for electromagnetic interference or unwanted emissions. The automotive industry tests vehicles for radiated emissions in huge TEM cells before placing them on the market. "It saves us about three days per car in testing time," says a Ford engineer. TEM cell techniques are included as part of electromagnetic interference standards by the Society of Automotive Engineers, the American National Standards Institute, and the Institute of Electronic and Electrical Engineers, among others. TEM cells now are produced by a dozen companies.

■ Large segments of the U.S. medical, agricultural, food processing, paper, plastics, and building materials industries save an estimated $500 million per year as a result of a NIST-developed method for measuring light reflection.

■ The National Association of Home Builders estimates that NIST recommendations for improved plumbing standards made possible hundreds of millions of dollars in savings in materials costs for the construction industry and for homeowners from reduced water usage.

■ NIST-developed smoke detector performance requirements, installation guidelines, and subsequent studies have played an essential role in establishing a $100 million U.S. residential smoke detector market and enabled U.S. manufacturers to acquire a 50-percent share of the world market. Since 1975, the percentage of homes protected with at least one smoke detector has grown to about 80 percent. This has been a major factor in the dramatic reduction in fire death rate in the United States, from more than 60 people per million population to fewer than 30 per million.

Law Enforcement

Since 1971, NIST has helped state and local police fight crime and lower costs by coordinating development of nearly 200 law enforcement standards. These standards include measurement methods and testing methodologies that help police make better use of evidence, ensure the quality of critical police equipment, and save tax dollars by improving police procurement.

■ NIST developed the computerized system the Federal Bureau of Investigation uses to match fingerprint evidence against 30 million records, so that local police can identify and arrest suspects. NIST researchers are now working to automate

the last remaining manual step in fingerprint analysis, an accomplishment expected to save the FBI 80 percent of its current labor costs for this procedure.

- A DNA profiling Standard Reference Material developed by NIST in 1992 has been key to establishing the reliability of this powerful law enforcement tool. Another NIST SRM for a newer, faster method of DNA profiling was issued in June 1995. "We don't like to go to court unless we have standard references that we can use in our testing," says David Bing of CBR Laboratory in Boston. "And you don't want the labs that are doing the testing to develop the standards because then there is no check on their objectivity."

- For the Department of Justice, NIST developed the performance standards now used throughout much of the world to test police soft body armor. According to industry figures, more than 2,000 U.S. police officers owe their lives to body armor, resulting in savings to taxpayers of over $800 million in death benefits and other costs.

- NIST standard test methods for radar guns and other speed-measuring devices have helped to improve substantially the accuracy of such devices. Prior to the NIST standard the reliability of radar devices was unknown and often was challenged successfully in court.

Health and Medicine

In matters of health and medicine, measurement errors and uncertainties can kill. In the case of radiation therapy, for example, an overdose can be lethal, while an underdose may fail to check the spread of a life-threatening tumor. Similarly, errors and uncertainties can undermine effective responses to public health problems, sometimes leading to erroneous conclusions that inflate risks and divert resources from legitimate public needs. As the nation's measurement authority, NIST laboratories provide services and conduct research that form much of the foundation for nationwide safety and quality-assurance systems that ensure the accuracy of health care measurements. In addition, NIST's measurement expertise and data services and its one-of-a-kind instruments have become valuable resources for health and biomedical researchers across the country. Finally, NIST experts often are called upon to speed or narrow the search for answers to suspected health problems, which often pose difficult measurement challenges.

- Accuracy of clinical measurements of cholesterol levels in blood serum has improved dramatically—to 95 percent, as compared with about 70 percent—since NIST issued a benchmark Standard Reference Material, a sample of serum containing certified amounts of human cholesterol. Greatly increased confidence in the results of cholesterol translates into better decisions on treatment and lifestyle management. "Every dollar spent at NIST for clinical laboratory standards has a multiplying effect of at least 10 times that in value for the public in improved diagnosis." —George Bowers, Hartford Hospital

- The 600,000 people who undergo radiation therapy for cancer each year and the several million more who undergo radiodiagnostic and radiotherapeutic procedures count on NIST calibrations, reference materials, and laboratory accreditation services to ensure the accuracy of radiation doses.

■ A NIST invention should significantly improve the quality of soft tissue images obtained in the more than 22 million X-ray mammography procedures performed each year. The improvement should translate into more accurate diagnoses, reducing the number of unnecessary biopsies (due to false positive results) and undetected tumors (due to false negative results). The new device, a spinoff from NIST's core competency in X-ray measurement technology, measures voltage applied to the X-ray source and the resultant energy distribution of X-rays that women receive during breast cancer screening 10 times more accurately than existing field calibration units. The new device "appears to be an almost ideal way of routinely measuring X-ray spectra from X-ray diagnostic machines."—T.J. Quinn, Bureau International des Poids et Mesures

■ NIST researchers also are developing new measurement technology with the potential to identify women at risk for breast cancer before they actually develop the disease. The new system, which measures tiny amounts of estrogen byproducts, capitalizes on an analytical technique that is more reliable, faster, and less costly than conventional methods of hormone measurement.

■ NIST studies of DNA damage by free radicals are helping uncover how these molecules promote certain cancers and other diseases. Among the benefits is a method for identifying and assessing molecular-level damage to DNA in cells and organs. Understanding the mechanism of DNA damage and repair potentially could help other researchers to develop the necessary means to prevent or repair the DNA damage in cells.

■ At the Center for Advanced Research in Biotechnology (CARB), which is sponsored by NIST, the University of Maryland, and Montgomery County, scientists have shed light on the structure for a series of important bacterial sugar-transport proteins that may help pharmaceutical companies design new antibiotics that target bacteria. CARB analyses of other proteins could be the foundation for developing more effective chemotherapy drugs as well as enzyme inhibitors that would make cancer cells more susceptible to chemotherapy.

■ NIST-led efforts are ensuring that international monitoring of ground-level changes in ultraviolet radiation will yield accurate, reliable measurement results, enabling scientists to assess the health effects of upper-atmosphere ozone depletion and the consequent increase in UV radiation.

■ NIST measurements were crucial to efforts that identified automobile emissions as a significant environmental source of lead, a toxic metal that is especially hazardous to children during neurological development. NIST's continuing support of efforts to reduce lead exposure includes more than 40 reference materials certified for lead concentration. These are used to ensure the accuracy of laboratory and field measurements of lead levels in, for example, blood and bone and of the lead concentrations on painted surfaces and in water. Reference materials containing certified levels of lead in soil samples are under development.

■ The NIST dental materials research program, a 67-year-old collaboration with the American Dental Association, continues to be the source of key enabling technologies that have helped to improve the practice of dentistry and the dental health of Americans. Some examples:

- NIST and ADA researchers developed the prototype technology leading to the air-driven turbine drill now found in virtually all dentist offices.

- A simple new shielding device developed by NIST and ADA collaborators will protect patients' healthy tissues from radiation while they undergo therapy for oral tumors and lesions. "I would not have been able to develop the new shielding method outside of NIST. By working here, I was able to draw upon the expertise of NIST metallurgists, polymer scientists, and radiation physicists."—Frederick E. Eichmiller, inventor of the new shielding technology

- A mercury-free dental amalgam developed by NIST and ADA researchers can eliminate concerns over the long-term effect of mercury-containing dental materials on public health and the environment.

- A substantially improved method for calibrating radiation doses delivered by a new neurosurgical tool called the gamma knife resulted from a collaboration involving NIST radiation experts, three oncology centers, and a New Jersey company. The calibration method is key to exploiting thin-film technology that generates pretreatment maps precisely indicating radiation targets within the brain and radiation-dose levels within the target area.

- NIST provides important research and measurement support to the nation's health and biomedical scientists. For example:

  - NIST-developed and -maintained databases ensure that biological models and the calculations they are based on use accurate, reliable data. One newly added database, for instance, contains evaluated data on the properties of more than 900 lipids, a group of molecules intensely studied by pharmaceutical and food technology researchers.

  - NIST research yielded reliable methods for measuring electric and magnetic fields from power systems. Widely adopted by researchers, these methods are needed to resolve questions concerning the health effects of exposure to electric and magnetic fields, asserted to increase the risk of leukemia, cancer, and other disorders.

  - NIST and University of Maryland researchers have determined the three-dimensional molecular structure of a liver detoxification enzyme, aiding efforts to explain how the liver filters cancer-causing substances from the body. The accomplishment could lead to more effective chemotherapy drugs.

National Defense

The U.S. Defense Department relies heavily on NIST measurement research, services, and facilities to ensure, for example, that:

- battlefield equipment performs effectively and reliably,

- military communications are not disrupted by technical failures, and

- impartial expertise is available to troubleshoot complex measurement problems encountered during development, manufacture, and operation of advanced weapon and communication systems.

From its very beginning as the National Bureau of Standards in 1901, NIST has contributed to U.S. efforts to build and maintain the world's best and most advanced national security system. Two of the first laboratories established at NIST were devoted to providing measurement support to shepherd development of an emerging advanced technology then being eyed for military communications—the radio. Today, the NIST laboratories are building the measurement base and defining the measurement standards needed for next-generation military technologies. NIST measurement techniques and reference standards are essential quality-assurance tools. They ensure high levels of confidence in the accuracy of measurements of diverse physical quantities—from laser power for advanced guidance and weapons systems to screw-thread dimensions of "submarine safe" fasteners to the mechanical properties of aerospace alloys.

- Across its vast network of facilities and contractors, the Defense Department specifies that systems and components be calibrated with equipment and methods traceable to NIST.

- NIST's success in developing the world's most accurate voltage reference source, known as the Josephson voltage standard, is paying national security dividends. The Army, for example, now has its own Josephson standard. The primary standard provides the Army with an added level of assurance that precision weaponry and other advanced instrumentation are calibrated accurately, preventing measurement uncertainties that can result in missed targets, surveillance failures, and inaccurate data transmissions. The Army will install a version of the standard directly into some of its equipment, leading to further performance gains and estimated annual savings totaling $3 million.

- "The system has proven to be a valuable addition to our high power microwave measurement capability, which as you know, is critical to many of the Army weapons, radars, and communications systems ... I believe your (NIST's) work ... has made significant contributions to the state of the art in high power microwave measurement metrology."—Senior Engineer, U.S. Army Primary Standards Laboratory Directorate

- NIST developed specialized equipment that the U.S. military uses to calibrate—and thereby ensure the accuracy of—range-finder and target-acquisition systems deployed on jets, helicopters, and missiles.

- During Operation Desert Storm, NIST scientists used their near-field antenna-scanning techniques to diagnose the causes of failures in a phased-array antenna that was part of a critical communications link between the United States and the theater of operations. Instead of being sent to the factory for conventional repairs, which would have taken months, the advanced antenna was rapidly diagnosed, repaired, and used throughout the conflict. The NIST precision antenna-scanning methods have been adopted by the Defense Department.

- NIST experts identified and solved a technical problem that had led inspectors aboard a U.S. Navy vessel to reject functional infrared-seeking missiles and order unnecessary and expensive rework. The NIST personnel pegged the problem to improperly calibrated testing equipment and provided a temporary measurement standard for use aboard the ship.

- When the Air Force learned that more than half of its coordinate measuring machines (CMMs)—key pieces of inspection equipment—failed their annual recertification check for accuracy, it immediately recognized that, because of measurement errors, inspectors may have been accepting bad parts and rejecting good ones. It turned to NIST for a solution, which then discovered similar problems at commercial manufacturing plants. Laboratory researchers developed an easy-to-use tool for quickly assessing CMM performance, making daily, rather than annual, evaluations practical. The NIST innovation is becoming an important quality-assurance tool for a growing number of manufacturers inside and outside the defense industry.

- NIST's ultraprecise time-keeping services, including development and operation of one of the world's most accurate clocks, are key supporting elements of the Defense Department's Global Positioning System, a satellite-based navigation network, and are essential to many commercial activities, from synchronizing telecommunications and electric power grids to time stamping international financial transactions and commercial-aircraft voice and data transmissions.

- NIST's unique responsibility for ensuring that U.S. measurements conform with international standards helps to guarantee that U.S. weapons and communications systems achieve necessary levels of compatibility with the equipment of NATO allies and that of other countries participating in joint military operations. Such measurements include frequency and power levels of radio communication systems and IFF—Identification Friend or Foe—systems; time scale for synchronization of operations, advanced telecommunications, and navigation; and dimensions of weapons, munitions, and interchangeable parts.

Environmental Technologies

NIST supports and complements industry efforts to develop, commercialize, and use environmental technologies. NIST has a demonstrated record of providing measurement methods, materials, and technologies; sensors; and evaluated data that are key to industrial process design and control, waste minimization and processing, and all types of environmental monitoring.

- NIST produces 230 different Standard Reference Materials that allow industry, university, and government researchers to measure more accurately pollutants in air, gas, water, soil, tissue, and other types of samples. Almost 10,000 individual units of these SRMs were sold by NIST in fiscal year 1994. Analysis of environmental pollutants often requires measurements of chemical concentrations at the parts-per-million or even parts-per-billion level, a precision that would be impossible without NIST SRMs, which are used to verify the accuracy of scientific instruments and laboratory procedures.

■ Facing a ban on ozone-destroying chlorofluorocarbons and the phaseout of related refrigerants, the nation's $17 billion air conditioning and refrigeration industry is using a NIST-developed database to calculate properties of alternative refrigerants and mixtures. More than 500 copies of the NIST database, called REFPROP, have been sold, substantially accelerating the progress the industry has made in designing systems that use more environmentally benign replacements.

■ Ten years of NIST research on the environmental effects of burning oil spills have provided state and local officials with the data they need to respond more effectively to such accidents. NIST laboratory research, field tests, and computer models have shown that more than 90 percent of spilled oil (contained with booms on open water) can be removed through burning and that soot particles from such burns are typically below hazardous levels within a few kilometers of the burn site. Mechanical cleanup of oil spills typically removes only about 10 percent of spilled oil from the water.

■ A NIST-developed system that uses microwaves to identify trace gases promises to make emissions testing much faster and easier for automotive, chemical, and environmental researchers. The automated system can measure many different chemicals directly from an emissions source in real time with sensitivities down to 10 to 100 parts per billion. The system replaces current gas emissions measurement methods that require time-consuming bagging of emissions gases and produce substantially less precise data on gas concentrations.

■ A better than tenfold improvement in the accuracy of asbestos measurements due to NIST-developed methods and SRMs has greatly decreased the number of false positive test results that erroneously indicated the need for asbestos removal. Asbestos removal cost building owners an estimated $3 billion in 1993.

■ Rhodium is a key ingredient in automobile catalytic converters that change polluting exhaust fumes into harmless gases. A NIST Standard Reference Material is helping manufacturers and metal recyclers measure rhodium concentrations as much as 20 times more accurately than is possible with current commercial standards. This means the SRM will help eliminate measurement errors in the $30 million world market for rhodium.

■ A related NIST SRM provides certified concentrations levels for rhodium, platinum, and palladium recovered from recycled catalytic converters. Before the SRM was issued manufacturers measuring these precious metals typically had measurement errors of about ± 8 percent. Using the NIST SRM, manufacturers can now measure these metals with a measurement error of ± 1 percent, an improvement with the potential to save the automobile industry millions of dollars.

Scientific Community

In the high-tech world, the measurement system is rapidly and constantly evolving. Length, for example, needs to be measured with increasing accuracy for precision machines to operate properly. Entirely new methods need to be developed to observe and measure phenomena related to integrated circuits and magnetic storage devices. Using specialized, often custom-built, instrumentation, NIST experts conduct a broad range of long-term basic research with the goal of advancing measurement methodology. The results of their research aid the entire scientific community, including researchers in academe, industry, and government.

- NIST researchers developed a source of polarized electrons that now is used widely in scientific and technological applications from studies of recording heads and media by corporate research laboratories to high-energy physics research. A second product of the NIST research was the development of the SEMPA technique used to look at the small magnetic structures in materials used in computer disks and micron-scale magnetic devices. NIST worked with researchers in industry, the military, and universities to apply SEMPA to their specific problems.

- More than 15,000 copies of NIST's Mass Spectral Database, which helps identify unknown chemical compounds, are used by academic and industrial scientists in chemical, pharmaceutical, food and beverage, rubber, petroleum, aerospace, telecommunications, and computer companies as well as hospitals, environmental laboratories, and law enforcement agencies.

- NIST researchers have achieved the coldest temperatures in the universe with lasers and magnetic traps that chill atoms to near absolute zero, far colder than interstellar space. Such experiments help to improve atomic timekeeping and can be used to advance experimental measurements since ultracold atoms are easier to manipulate than room-temperature atoms. These experiments may lead to a better understanding of quantum effects, such as superconductivity, as well as exotic forms of matter.

- Pharmaceutical companies and biological researchers are using NIST's Biological Macromolecule Crystallization Database to develop new drugs and to study protein structures. The database includes data on more than 2,000 crystal structures of 1,500 biological proteins and macromolecules. Growing protein crystals is often the first step in determining a protein's structure.

- An instrument developed at the NIST Cold Neutron Research Facility offers materials scientists in academia and industry an improved way to analyze hydrogen, which can embrittle metals found, for example, in jet engine turbine blades. NIST chemists are also developing reference standards for verifying the accuracy of analyses of hydrogen in metals.

- NIST researchers are investigating ways to tie the kilogram, the only international unit still based on a physical standard, to an invariable natural constant. The current kilogram mass standard is available in only one laboratory and can change weight due to dust and cleaning. The redefined kilogram standard would be more accurate and accessible to researchers worldwide.

■ Scientists and engineers rely on atomic spectral data constants from NIST in new product development as well as to further understanding of the universe. For example, the semiconductor industry needs atomic spectral data when evaluating the characteristics of plasma gases used to etch semiconductors. Similarly, astronomers use spectral lines from stars to determine which elements are contained in a particular star.

■ Using ultrafast optics and lasers, NIST physicists and chemists are opening a portal through which they can view the subtlest and quickest changes in atomic motions. Understanding these ultrasmall, ultrafast changes could lead to new avenues for controlling chemical reactions at surfaces. This emerging field of femtosecond (quadrillionth of a second) chemistry could enable scientists to break chemical bonds selectively, spur reactions, and choose desired products.

■ NIST's Synchrotron Ultraviolet Radiation Facility calibration facility is used in concert with NASA shuttle flight observations to record accurately the output of solar radiation. Data on solar radiation must be collected accurately over decades in order to frame scientifically valid regulatory policies on CFC compounds and determine the effect on stratospheric ozone.

■ NIST physicists are making some of the most precise measurements ever of the neutron lifetime. Among the benefits of this research is a clearer view of one of the forces acting on subatomic particles as they cooled after the Big Bang. This so-called "weak force" is one of four forces in the "Standard Model," which physicists use to explain the behavior of particles.

■ NIST's Electron Beam Ion Trap offers a window to otherwise inaccessible aspects of nature. Scientists now are using this instrument to learn more about the nature of space and time and to understand better energetic astrophysical phenomena. It creates highly exotic forms of matter by stripping most or all the electrons from atoms held in its core with a strong magnetic field.

June 1995

STANDARDS, MEASUREMENT, AND THE NIST LABORATORIES: DON'T LEAVE YOUR ECONOMY WITHOUT THEM

Next time you take a drive, pull over to a convenient spot and consider what it took to get you to buy that car. Open the hood and check out the guts of the automotive organism. Open its doors and trunk. Look underneath its chassis.

To make this piece of machinery, thousands of components had to fit together into various systems, which, in turn, had to fit together into a product that looks sleek and hums when it runs. Ungraceful contours, unsubtle gaps between body parts, rattles, squeaks, even the way a car door feels and sounds as it opens and closes, play into buying decisions. Considering that car makers receive components and systems from thousands of suppliers—each one using their own equipment, workers, and quality control procedures— it is almost a miracle that cars roll off the lines looking as sleek and humming as calmly as they do.

What makes auto making a feat of mass manufacturing, and not a miracle, is a vast, yet unseen, infrastructure of standards and measurement protocols. A rose may be a rose may be a rose to all of humanity, but one manufacturer's thousandth of an inch or millimeter is not necessarily another manufacturer's thousandth of an inch or millimeter. Unless, of course, the measuring tools and methods they each use are calibrated and certified by common standards of the highest accuracy and reliability. The same dependence holds for every other industry whose manufacturing processes and products rely upon standard practices and accurate chemical, physical, and engineering measurements. A very short list of these measurements includes length, temperature, voltage, resistance, current, chemical composition, hardness, color, luminosity, tensile strength, radioactivity level, viscosity, and particle size.

The Supreme Court of Measurement

This is why the laboratories at the Department of Commerce's National Institute of Standards and Technology (NIST) are of prime importance in thousands of industrial settings distributed in every state of the Union. Without the standards of measurement developed and maintained by NIST laboratories, domestic industry in general would suffer a great, or even crippling, disadvantage when it comes to certifying products for ever more global markets. A ticket to international trade is the ability of a manufacturer to trace factory measurements and product specifications through a chain of standards or calibrations that ultimately are anchored to measurement bedrock, that is, to a globally recognized measurement laboratory. In the United States, that means NIST. Germany, Japan, and other industrialized countries have their own counterparts.

The importance that standards of measurement would have to the country was not lost on the 18th-century framers of the U.S. Constitution. They considered the governmental role of creating and maintaining standards of measurement—in their lingo "standards of weights and measures"—so critical that it is one of the very few government functions explicitly called for in the Constitution. How else could citizens be assured that an ounce of gold in Delaware was the same as an ounce of gold in Massachusetts?

U.S. Department of Commerce/Technology Administration
National Institute of Standards and Technology
July 1995

After a century more of the industrial revolution had unfolded, the U.S. Congress reiterated the importance of creating and maintaining standards of measurement by mandating in 1901 the creation of the National Bureau of Standards, later to be expanded and renamed as NIST. Private companies wouldn't fulfill the function of making measurement standards, which was rendered all the more imperative by the rise of mass manufacturing, since investment in standards making would be hard or impossible to recoup. And while voluntary standards organizations, which have been privately created and maintained, have played an irreplaceable role in promoting compatibility in a variety of product lines, there still remains a vital function to be filled by a public agency like NIST. For one thing, private standards organizations promulgate only written standards of design or practice, not measurement standards. Moreover, NIST ensures equitable access to measurement standards. It maintains the necessary impartiality to serve as a "Supreme Court of Measurement" when disputes arise, and its global credibility is critical for U.S. firms selling goods and services abroad.

Since its founding in 1901, NIST has played these roles. It has provided U.S. industry with an enormous variety of crucial measurement services, including calibration services; "evaluated" data for assessing and certifying the performance of factory instruments such as temperature-measuring thermocouples; and now about 1,350 Standard Reference Materials—the equivalents of certified "rulers," which companies use to check the accuracy of all kinds of scientific and engineering measurements. Non-government testing organizations and laboratories also rely on NIST's measurement expertise for assistance in certifying that the products of their constituencies meet voluntary or government-mandated performance and safety specifications.

As manufacturing processes become more exacting, as factory efficiency goes up, and as more commerce is done with more and more demanding trade partners, the importance of metrology—the science of measurement—mushrooms. In trade, potential overseas partners will go elsewhere if U.S. manufacturers cannot build and test products with measurement standards that ultimately are traceable to NIST or one of the other world-class metrology labs around the globe. An estimated $20 billion or more of trade in Europe alone is at issue. In cases where suppliers, customers, or even rival companies within an industry need a standard to base the collective development of products, NIST serves as a third-party venue with the technical expertise and proven track record of impartiality to make this kind of cooperation possible.

The Incredible Ubiquity of Measurement

These themes are on the minds of the technical community all over the world. At a 1994 meeting of the Japanese Instrument Manufacturers Federation, J. Terry Quinn, director of the International Bureau of Weights and Measures, which is located in France, spoke eloquently about the many ways confident and accurate measurement enters modern life and commerce.

"It allows high volume goods, such as crude oil or natural gas, to be traded in the secure knowledge that the millions of tons of oil or cubic meters of gas bought and sold are correctly measured from the supertanker to the petrol pump and from the high-pressure cross-border pipeline to the domestic gas meter," Quinn said. It is to NIST, for example, that the accuracy of every watt-hour meter on the side of every home in the United States is traceable, a situation without which fair and open transaction between electrical utilities and the United States 260 million citizens would be difficult to ensure. It is also due to NIST that vendors and buyers of liquid hydro-

carbon products such as butane and propane, which are derived from natural gas, actually consummate multimillion dollar deals instead of engaging in expensive, time consuming, and acrimonious courtroom debates about how much product in fact did change hands. The technical preventative here is an extraordinarily detailed and accurate set of measurements by NIST researchers on the relationship of temperature, which fluctuates daily, to the volume of these hydrocarbon commodities being pumped from sellers to buyers. These provide a basis for agreement and for adjudicating disagreements.

Quinn listed more ways that measurements enter modern life and commerce: "It is a truism that accurate measurements are required for the efficient manufacture of components for such varied things as internal combustion and gas turbine engines, where reliability and long life depend upon manufacturing tolerances of micrometers; and in compact disc players, which incorporate lenses to focus laser light that are made to tolerances below a tenth of a micrometer." For comparison, the width of a single bacterium is roughly a micrometer. "In terms of high technology production, the list of applications requiring accurate measurement is endless," Quinn told his mostly Japanese audience.

Medicine. Take cholesterol measurements as a particularly personal example. When high levels of this blood component first were linked to heart disease in the 1970s, clinical measurements of cholesterol levels in blood serum were bound to become the basis for lifestyle-changing decisions for many thousands of people as well as for a big new business for testing laboratories. Yet the accuracy of tests at the time was no better than about 30 percent. This gaping uncertainty was due in large part to the absence of standards to serve as benchmarks for each clinical lab and as a means for revealing interlaboratory differences. Researchers at NIST developed a cholesterol Standard Reference Material (SRM) that quickly helped to improve the accuracy of clinical serum cholesterol testing to the 5 percent range. All serum cholesterol measurements are now traceable to this SRM. Doctors and patients can feel more confident in the actions they take based on the measurements, which amount to a multimillion dollar market in clinical analyses.

There is another arena of medical technology where accurate measurement perhaps is even more critical. The safe use of X-rays and radioisotopes used for medical imaging or cancer treatment depends upon knowing dose, which depends entirely upon accurate measurement of radiation and radioactivity levels. In the United States, labs responsible for measuring the activity levels of radioisotopes keep themselves accurate and competent, for example, by voluntarily participating in measurement round-robins coordinated by NIST using standard preparations of radioisotopes prepared and certified at NIST.

Communications. Another industry to which accurate measurement is vital is communications. Without the ability to measure time with almost unimaginable accuracy, modern global communication systems quickly would break down into a morass of crossed signals and delays. Communications satellites or optical fibers in a transoceanic communications cable can carry tens of thousands of active international links simultaneously because time scales around the world are closely coordinated to the point where the world's most accurate clocks are synchronized within about a microsecond.

The only way this millionth-of-a-second coordination and stability can occur is because researchers at NIST and the other major metrology labs in the world have been developing and maintaining ever more accurate atomic clocks. In these devices, a second is defined as the duration during which a cesium atom oscillates

9,192,631,770 times(that is more than 9 trillion cycles!) between a pair of energy states. Since this oscillation frequency is the same no matter what the temperature, humidity, or pressure happens to be, it can serve as a reliable time ruler that is the same throughout the world at every moment. No other kind of clock, whose timekeeping depends on such variable physical phenomena as the tension of a spring, the swing of a pendulum, or astronomic cycles, could have this kind of around-the-world, all-of-the-time stability.

Without atomic clocks, military missiles and other spacecraft would operate only within harrowing levels of navigational uncertainty regarding the vehicles' actual locations. Atomic clocks even have spawned entirely new commercial ventures. Although the U.S. Department of Defense established a series of 24 satellite-borne atomic clocks—part of the Global Positioning System (GPS)—for its own military navigational purposes, the GPS has become the basis for civilian applications in which air, land, and sea shippers, even technophilic wilderness hikers, can keep extremely close and relentless track of what spot on Earth they happen to be at at any particular moment. GPS-based services have grown into the big-business, multibillion dollar club. This is what the present state of the art of atomic timekeeping has wrought. Each leap in the accuracy of time measurement is likely to open more possibilities in communications capacity and technology, to improve domestic and space navigation, and to open doors to unseen commercial avenues.

Manufacturing. Modern chip manufacturers now are spending $2 billion to $3 billion sums to build the next generation of chip-fabrication facilities. In these near future bastions of highest technology, moon-suited engineers will oversee the world's most precisely controlled machinery operating in the world's cleanest rooms to make the world's most intricate devices. A good portion of the nation's gross national product and global economic position will depend on the smooth operation of these "microfabs." As it has for previous generations of chip making, a credit-card-sized item—called a stepper gauge—provided by NIST—will be crucial.

Each stepper gauge consists of a glass slide with several series of microscopically thin lines of chromium whose widths or line-to-line distances have been measured at NIST with an accuracy and reliability that all players in the industry can trust. These serve as minuscule calibration rulers for the many microscopic analyses that chip factory workers must carry out every day. For example, stepper gauges provide chip makers with the means of checking that the lithographic masks they use for patterning circuitry onto their chips have been prepared as designated by circuit designers. Since one mask can lead to many thousands and even to millions of chips, knowing that they are right to begin with is essential.

The stepper gauges still will serve well enough in the next round of microfabs, but they may not be up to the job five years from now. In anticipation of the electronics devices of the next century, a group of NIST researchers has been developing an entirely new kind of ruler—the Molecular Measuring Machine. This future-is-now device will be able to measure distances with an accuracy of about 2 billionths of a meter (about the size of a protein molecule) over a range half the size of a dollar bill. That may sound like an unnecessary exercise in measurement machismo, but as chip components continue to shrink, manufacturing errors even on these diminutive dimensions will spell "no sale." With tools like the Molecular Measuring Machine in hand, U.S. industry will avoid finding itself in the future merely wishing it had the sophisticated leading-edge measurement capabilities required for efficient, competitive production.

International Standards. As the marketplace for more products and services becomes more global, the role of measurement in trade stands out in stark relief. U.S. companies sold more than $500 billion worth of goods overseas in 1994, and the world marketplace increasingly requires manufacturers to demonstrate that their products meet specific standards before they may be traded. It is through measurements of all kinds that domestic companies will be able to adapt factory processes and practices to meet specifications of foreign markets. Measurements also are at the heart of an unseen infrastructure of testing and calibration laboratories that carry out many of the certifications required by foreign countries before U.S. products can be shipped to their shores. For many regulated products, foreign governments will accept U.S. tests of a product's conformance to a standard only if the U.S. government—NIST, more specifically—backs the quality of those tests. A product's quality obviously has great bearing on its chances in a competitive market. However, it is the measurement-intensive infrastructure for demonstrating conformity to standards that allows them to enter the competition at all.

The Final Measure

In 1994, the United States invested just over 0.003 percent ($226 million) of its GDP ($6.74 trillion in current dollars) on its publicly funded metrology infrastructure based at NIST. NIST's roles are too varied and wide ranging for economists to quantify confidently what the economic return on this investment actually is. In his talk to the Japanese instrument makers, however, Quinn tried boiling down what metrology in general means for an industrial nation's economy—between 3 percent and 6 percent of the gross domestic product is what he estimated. For the U.S. economy in 1994, those percentages correspond to roughly $200 billion to $400 billion. What is clear is that NIST is a critical ingredient in this conspicuous hunk of the economic pie.

ANNUAL REPORT
1995

THE VISITING COMMITTEE ON ADVANCED TECHNOLOGY
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

FEBRUARY 1996

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THE VISITING COMMITTEE ON ADVANCED TECHNOLOGY 1995

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FOREWORD

Continuing the pattern of recent years, 1995 was a year of change and growth for NIST. The Administration and the Congress continued to make technology a priority, with the Department of Commerce being a key player. NIST's Director, Arati Prabhakar, continues to be a very visible and articulate spokesperson for NIST and for its collaboration with and support of U.S. industry. Under her leadership, the Advanced Technology Program (ATP) expanded to include focused program competitions. Eleven such competitions were held in Fiscal Year 1995, following the first five held in Fiscal Year 1994. The Manufacturing Extension Partnership (MEP) increased the number of Manufacturing Technology Center awards to 60, making this a truly national program. The Baldrige Quality Program conducted pilot programs in health care and education. The NIST laboratories are carrying out a strong research and development effort, planned and implemented in cooperation with industry, to address industry's need for generic measurement technology, measurement standards, calibrations, test methods, and evaluated data.

The President's proposed Fiscal Year 1996 budget included substantial increases for NIST programs across the board and would have given NIST the means to expand and enhance its industrial outreach programs and to take more control of its laboratory research agenda. The Congress is presently considering significant reductions in the NIST budget, including a zero appropriation for the ATP and substantial reductions for the construction of facilities. The Fiscal Year 1996 budget decisions were not final at the time this report was written. However, we note that the impact of terminating the ATP would be severe. A large percentage of ATP projects would have to be terminated prematurely, and the remainder would have to operate at subcritical levels. The reduced construction funding would allow construction of an Advanced Chemical Technology Laboratory, but would delay by at least a year the start of construction on much-needed advanced technology laboratories in Gaithersburg and Boulder. We continue to believe that the

construction program that was in place at the start of 1995 is a good one and should be executed, even if delayed. The extramural programs of NIST (the ATP, MEP, and Baldrige programs) are in our view sound programs, are contributing to the economic health of the nation, and are a wise use of the taxpayers' money.

We wish to note that this year's report was delayed by the lengthy government shutdown.

The Visiting Committee on Advanced Technology

February 1996

National Institute of Standards and Technology

Organizational Chart

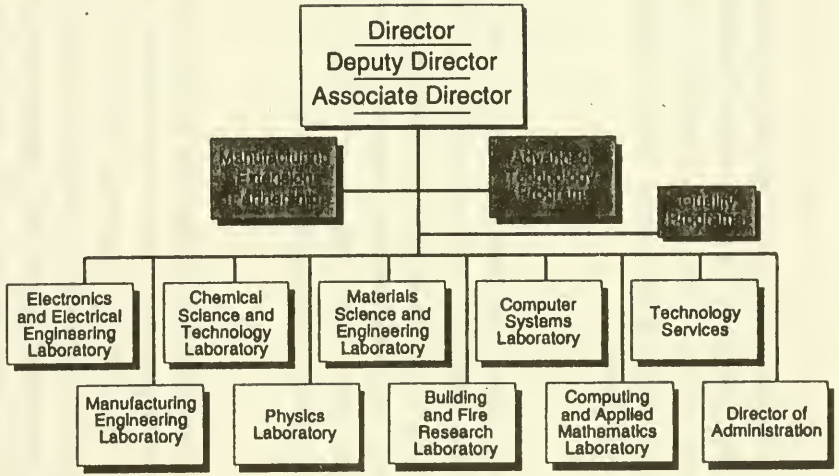

Figure 1

INTRODUCTION

Committee Charter and 1995 Activities

The Visiting Committee on Advanced Technology of the National Institute of Standards and Technology (NIST) was established by the Omnibus Trade and Competitiveness Act of 1988. The committee reviews and makes recommendations regarding the general policy, organization, budget, and programs of the Institute.

The committee holds four business meetings each year with NIST management and schedules additional meetings on specific subjects as necessary with senior officials from NIST and the Department of Commerce. In March 1995, the 1994 Committee Chairman met with the Secretary of Commerce and other senior department officials to summarize the committee's 1994 findings and recommendations.

The committee summarizes its findings each year in an annual report that is submitted to the Secretary of Commerce and transmitted by the Secretary to Congress. The report addresses issues that affect NIST or are of concern to the committee in its role as NIST's private sector policy advisor. A central theme of this year's annual report is NIST's progress in assessing the results of its programs in support of industry and the nation. We review and comment on current issues in the Institute's laboratories and program areas. We also discuss the NIST facilities initiative, which we believe is crucial to the long-term institutional health of the NIST laboratories.

Each year the committee conducts studies and prepares additional reports on

specific policy matters as it deems appropriate. This year the Committee helped to organize a working conference, "Global Growth of Technology: Is America Prepared?" and participated in the conference. The conference was sponsored by NIST and the Council on Competitiveness. A complete report will be issued in 1996.

Appendix A of this report summarizes the Visiting Committee's meetings, reports, and other activities for 1995. The appendix also gives the address from which the Visiting Committee reports and other information on committee activities can be obtained.

BUDGET AND PLANNING

Mission

The NIST mission is to promote U.S. economic growth by working with industry to develop and apply technology, measurements, and standards. It carries out this mission through four major program areas:

Laboratory Research and Services – develops and delivers measurement techniques, test methods, standards, and other types of infrastructural technologies and services that provide a common language needed by industry in all stages of commerce – research, development, production, and marketing.

Advanced Technology Program (ATP) – provides cost-shared awards to companies and company-led consortia for competitively selected projects to develop high-risk, enabling technologies during the pre-product development phases of research and development.

Manufacturing Extension Partnership (MEP) – a growing nationwide network of extension centers, co-funded by state and local governments, that provides small and medium-sized manufacturers access to technical assistance as they upgrade their operations to boost performance and competitiveness.

Baldrige National Quality Program – with industry, manages the Malcolm Baldrige National Quality Award, which may be awarded

annually to companies in the categories of small business, manufacturing, and service and provides U.S. industry with comprehensive – and extensively used – criteria for quality management and performance improvement.

The NIST organization chart, shown in Figure 1, remained unchanged in 1995. However, NIST has announced that it plans to combine the existing Computer Systems Laboratory and Computing and Applied Mathematics Laboratory to form a new Information Technology Laboratory. The proposed new Laboratory will be discussed later in this report.

We are pleased to report that during the past year a number of key positions at NIST were filled with experienced persons who should be able to provide the outstanding technical competence and leadership which are required in NIST's major program areas. This addressed a concern expressed in our 1994 Report (1).

During the year we received reports on significant developments in each of the four major program areas, as well as regular updates on the state of affairs with the Congress and the Administration. Each of these areas will be reviewed below.

Budget

We received several updates on the NIST budget and budget plans in progress from Director Arati Prabhakar. She pointed out that NIST continues to receive strong support from the White House and from the Department of Commerce. A budget total of $854 million was appropriated for Fiscal Year

1995 out of a request of $935 million. Rescissions during Fiscal Year 1995 reduced the NIST budget to about $700 million. The net changes from Fiscal Year 1994 were: Laboratory programs were increased by 9% to $247 million, the Advanced Technology Program (ATP) from $200M to $341 million, the Manufacturing Extension Partnership (MEP) from $30M to $74 million, the Baldrige Quality Program remained unchanged at $3.4 million, and construction of research facilities decreased from $62M to $35M. This budget allowed NIST to move ahead in all of its major program areas.

The President's budget request for Fiscal Year 1996 was just over $1 billion and would have brought NIST's budget to 1.1% of total Federal R&D. Prabhakar pointed out that NIST focuses on longer-term and riskier infrastructural technologies, a very appropriate role for federal R&D. NIST's work is driven by industry priorities, and involves thorough evaluation and rigorous, open, competitive processes.

We listened during the year with interest, amazement, and concern about the twists and turns of the Congress and its attempts to deal with the Department of Commerce and NIST. We participated in this process by testifying to the House Committee on Science.

As this report was going to press, a continuing resolution, effective through March 15, 1996, provided funding based on annual levels of $259 million for Laboratory programs (including $2.9 million for the Baldrige Quality Program), $255 million for ATP, $80 million for MEP, and $60 million for construction of facilities. These levels, if continued through the year, would provide funding for ongoing programs, for announced ATP awards, and for construction of an Advanced Chemical Technology Laboratory in Gaithersburg. It appears that the Institute has weathered the storm quite well but its extramural programs are much reduced from the President's request.

Measuring Results

Much of NIST's strategic effort this year has concerned the measurement and assessment of effectiveness of each of its four major programs, i.e., the impact on customers in industry and elsewhere. An earlier report, "Setting Priorities and Measuring Results at the National Institute of Standards and Technology," (1) discusses how NIST addresses these issues. The operational aim is to focus and leverage Federal expenditures so that relatively small investments yield meaningful economic benefits for the nation. Priorities are set, operational performance is evaluated, and near- and long-term returns are assessed on the basis of benefits realized by U.S. industry. We continue to believe that this is a sound approach.

This year, NIST issued a report (1) giving a progress report on how NIST is delivering results that translate into competitive advantages for individual companies and entire industrial sectors, and, ultimately, into benefits for the U.S. economy. A companion report (1) presents 40 representative examples of industrial impacts of each of the four major NIST programs. These examples, which involve 79 companies, describe new products, accelerated R&D, and increased efficiencies resulting from NIST's programs and its interactions. In our opinion, NIST is very effective in delivering results which have significant economic impact.

Four new rate-of-return studies (1)(1)(1)(1) for the NIST laboratories were completed in Fiscal Year 1995, showing clearly that the laboratories are focusing on areas where they have broad economic impact. The rates of return compare very favorably with similar studies reported for industrial innovations and for company use of academic research. Further discussion regarding the

assessment of effectiveness for the Advanced Technology Program and for the Manufacturing Extension Partnership is given later in this report.

CAPITAL IMPROVEMENTS FACILITIES PROGRAM

In a special report issued in 1990 (1), we concluded that: "NIST's physical plant is deteriorating and urgently needs attention that requires budgetary action. Aging and obsolescence, coupled with years of underinvestment due to insufficient funding, have produced critical deficiencies in NIST's facilities that must be remedied. At present, some of the Institute's facilities are inadequate for world-class science and engineering research, and for scientific and technical support to our nation's industry." In our 1993 report (1), we concluded that "The single most important problem to the long-term health of the NIST laboratories is, in our opinion, the substandard condition of the physical plant." We supported the repair and upgrade of NIST's facilities in testimony to Congress and in meetings with senior officials at the Department of Commerce. A ten-year $540 million capital improvements facilities program received broad support and was approved.

Sam Kramer, NIST Associate Director, reported to us on the status of the NIST Capital Improvements Facilities Program (CIFP). He pointed out that the facilities at the Gaithersburg and Boulder sites are over 30 and 40 years old, respectively. These facilities no longer provide adequate temperature and humidity control, vibration isolation, electrical services, and air cleanliness to meet today's research and program needs. Furthermore, the performance of the existing laboratories has deteriorated with age and will continue to worsen as future program needs increase and deterioration continues. He noted that a 1992 external study concluded that a multi-year capital improvements facilities program was required, totaling $1.2 billion. The present $540 million CIFP addresses the most critical issues.

At Gaithersburg the CIFP includes construction of a new Advanced Technology Laboratory (ATL) ($150 million) and renovations of some of the

25-434 O - 96 - 5

general purpose laboratories and other buildings. At Boulder it includes construction of a new central utility plant (CUP, $26 million), construction of a new ATL ($61 million), and renovations of several existing buildings. The CIFP was later modified to include construction of a new Advanced Chemical Sciences Laboratory (ACSL, $57.4 million), utilizing a design-build approach, in place of renovating existing chemistry laboratories. This modification reduces the schedule for delivery of advanced chemical laboratories by eight to twelve months.

Accomplishments of the CIFP to date include construction at Gaithersburg of a new chilled water pumping system, addition of a 3000 ton chiller, and addition of a 3000 ton cooling tower cell. Research was completed on the design of laboratories to achieve the needed levels of temperature control and vibration isolation. Mock-ups of laboratory and office modules were constructed. Designs were completed for the Boulder and Gaithersburg ATLs, for the Gaithersburg ACSL, and for the Boulder CUP. Construction bid documents were completed for the CUP and ACSL. Environmental assessments were completed and approved for the Gaithersburg ATL and ACSL. The assessment for the Boulder ATL is expected to be completed by early next year. He noted that the contract for the ACSL is imminent, with occupancy in about June 1998 (the contract has since been let).

A new six-story building (NIST North) was built in response to a NIST lease solicitation directly across the street from the main Gaithersburg campus and accepted for occupancy on October 20, 1995. This space is needed to create a place to put part of the NIST staff in order to have maneuvering room for the renovations of NIST's permanent facilities. The primary occupants are to be Technology Services and the components of the planned Information Technology Laboratory. Moves into NIST North were completed on schedule in mid-December. The building has a built-in voice and data communications system connected to the main campus, and provides additional conference space.

Sam Kramer's report on the status of the Facilities Construction Program was of particular interest to the Committee. We continue to believe that the program which was in place at the start of 1995 was a good one and should be executed even if delayed by this year's congressional action. NIST should be commended for its use of industry rather than government standards and for the use of commercial practices rather than traditional government procurement practices in the conduct of this program. Experiences at other national laboratories have shown that these practices should result in substantial reductions in both cost and time.

STANDARDS AND INTERNATIONAL TRADE

Belinda Collins, Director of NIST's Office of Standards Services, discussed with us the importance of national and international standards and reviewed NIST's programs in these areas. She emphasized that the U.S. standards process is primarily private sector and voluntary; that better cooperation and communication is needed among standards organizations, industry, and government; and that a national strategy is needed. She noted the 1993 recommendations of the Visiting Committee (1) and outlined how NIST is responding to each of these recommendations. For example, NIST is working with the American National Standards Institute (ANSI) to develop electronic availability of standards and standards information through the National Standards System Network, and standards assistance programs are expanding with experts located in several foreign countries. Efforts are underway to increase the participation by U.S. experts in international standards activities, and to facilitate the international recognition of U.S. conformity assessments. Collins emphasized that NIST is committed to strengthening its ties with the private sector and with other government agencies to develop and implement a strategic standards process.

Peter Heydemann, Director of NIST's Technology Services, discussed NIST's international standards activities. Heydemann pointed out that nationalism played an important role in the negotiation of the World Trade Agreement. Industry not only faces a more global market, but it faces one in which governments set up barriers to trade, often based on measurement and normative standards and on conformity assessment. Heydemann stressed that it is no longer sufficient that a product has a large market, is of good quality, and is reasonably priced. One or more technical barriers to trade must almost always be overcome or dealt with in a constructive fashion to gain access to the market before anything can be traded. Standards are both a potential barrier and enabler. It is important that NIST play its role effectively.

Heydemann pointed out that NIST has always been very much engaged in supporting industry and the government in the development of standards, but it has rarely tried its hand at overcoming technical barriers to trade. On the other hand, NIST has the stature and the staff to do this successfully. He outlined what NIST is doing to support U.S. industry in the global market place.

Peter Heydemann gave us a very good perspective on the international standards and standardization activities of NIST. He provided the committee with continuing reasons to believe that this area is important to the country, an important NIST responsibility within the government, and probably needs more resources and attention in the future. This view is consistent with the recommendations in a recent report (1) prepared by the Board on Science, Technology, and Economic Policy of the National Research Council. The importance of this effort is clear to us, and a broad vision of how to proceed appears to be evolving within NIST. However, we requested that a more tangible plan for this evolution be developed to serve as a guide to action and predictor of capabilities and costs for the next few years.

In response to our request, Peter Heydemann discussed plans for the NIST's Standards in Trade and International Standards Programs. He reviewed the many ways in which NIST work supports product development, production, and marketing. He pointed out that NIST is working to overcome standards-based barriers to trade through participation in national and international committees, through mutual recognition agreements, through accreditation and assessment programs, and in many other ways. These activities are carried out in coordination with other government agencies and the private sector. Heydemann outlined what NIST plans to do to support U.S. industry in the global market place, and reviewed plans for increased efforts in South and Central America, and in Russia and the newly-independent states (NIS).

Heydeman's presentation addressed a subject of great interest to the Committee. It demonstrated some interesting activity, and we are encouraged with the new initiatives. We would note, however, that it is not yet a strategic plan. A measurable set of objectives, milestones, resources needed, etc., is needed. We recognize that the Congress is causing some turbulence in the projected resources and the historical base for this activity has not been substantial but we continue to believe that NIST must make this function one of its primary missions.

THE NIST LABORATORIES

At the heart of NIST are nine laboratories (eight laboratories when the formation of the new Information Technology Laboratory from two existing laboratories is approved) which carry out a strong research and development effort, planned and implemented in cooperation with industry, to address industry's needs for generic measurement technology, measurement standards, calibrations, test methods, and evaluated data. NIST's reputation for impartiality and technical excellence allows it to act as an independent third party in resolving technical problems and in bringing industry together to anticipate future needs for measurement technology.

During the year we received regular updates from NIST Director Arati Prabhakar on the status of the laboratories and made five laboratory visits. We received two reports from the National Research Council's Board on Assessment of NIST Programs and a report from the Laboratory Council. We discussed with the Laboratory Council the laboratory mission statement. We began an assessment of the planning for the new Information Technology Laboratory and took a first look at NIST's biotechnology program. These areas are discussed below.

Board on Assessment Reports

Wilmer Bottoms, Chairman of The Board on Assessment of NIST Programs, provided us with overviews of the Board's Fiscal Year 1994 and 1995 assessments of the NIST laboratory programs. Their published reports (1)(1) should be consulted for details. The activities and conclusions of the Board on Assessment represent an important element of the governance of NIST. They also showed an improvement in the quality of that activity.

In his report on the 1994 evaluation, Bottoms noted that much progress has been made in the development of laboratory strategic plans, and pointed to the need for further development of these plans. He noted that industrial input is universally used by the laboratories in their planning. Bottoms recommended that the laboratories continue to improve their coupling with the industrial customer base, and identify appropriate metrics to judge the success of their work. He noted that some units are still too dependent on funding from other government agencies. There is a need to retrain staff from long-term other-agency projects now ending. Bottoms stressed the increasing importance of interdisciplinary and interlaboratory programs, and that the reward system should encourage such collaborations. He stated that the overall quality of the laboratory programs is excellent, and gave several outstanding examples.

Bottoms noted the NIST plan to form an Information Technology Laboratory (ITL) from the present Computer Systems Laboratory and Computing and Applied Technology Laboratory. He stressed the importance of maintaining their essential core capabilities and of involving the current division leaders in planning the new laboratory. He informed us that the Board on Assessment has formed a new Information Technology Panel to assess the two laboratories in 1995. The ITL is addressed further later in this report.

Strategic planning in the individual laboratories continues to improve. Bottoms reported to us that strategic planning processes are implemented within most laboratories and that all laboratories solicit industry input into their planning. The Board concluded that continued refinement of planning is needed and that priority-setting could be more focused. They cautioned that industrial input should not supplant the role of NIST staff in anticipating long-term needs for standards and technology. We agree with the Board's recommendation that strategic planning should extend across laboratories. The formation of the new Laboratory Council, composed of the Laboratory

Directors, is a step in the right direction. The Laboratory Council sponsored and participated in six strategic planning workshops during the past year: measurements and standards in international trade; optical data storage; magnetics – measurement challenges and opportunities at small length scales; information – data, digital libraries; modeling and simulation; and micro-electromechanical systems.

In Bottoms' review of the Board's 1995 evaluation of NIST laboratory programs, he noted that the Board was charged with evaluating the quality and effectiveness of current technical programs, priorities and the priority setting process, the status of equipment and facilities, impacts on industry and how they were measured, the Industry Fellows program, and data programs. The Board concluded that the quality of NIST laboratory programs is very good to excellent, and that some work could be even more effective if resources were better allocated against priorities. The Board judged that there has been continuous improvement in NIST laboratory programs, and that the NIST staff is focused on their objectives despite uncertainties about the NIST budget. Bottoms presented the Board's analysis of each item in their charge, including accomplishments, strengths and weaknesses, and specific recommendations for improvement. The current status of laboratory equipment was judged to be very good overall, but the Board concluded that major problems with facilities will result if the new construction in the Capital Improvements Facilities Plan (see pp. 5-6 of this report) is canceled or delayed. Bottoms concluded with a discussion of the organization of the Board and their Evaluation Panels, and noted that about 58% of the members are from industry.

The Board's assessments of the health of the NIST laboratories were very positive and we want to congratulate the Institute for conducting its activities so as to solicit such a favorable review. Their suggestions of opportunities for improvement also seemed soundly based and we recommend that they be

considered.

Laboratory Mission

Lyle Schwartz, Chairman of the NIST Laboratory Council, provided us with an overview of the Council and the laboratory programs. He pointed out that the Council is composed of the Directors of NIST's nine technical operating units (eight Laboratories and Technology Services) and meets biweekly. This year the Council held an offsite strategic planning meeting and subsequent meetings with Division Chiefs to create a draft laboratory strategic plan containing the laboratories' vision, values, mission, and goals. This statement was revised following discussions with the Committee:

Vision: The National Institute of Standards and Technology shall be the world's leader in measurement standards, recognized for its impact on the U.S. economy.

Values: We value our reputation as a world class laboratory for excellence, objectivity, creativity, and responsiveness.

Mission: To promote the U.S. economy, the Laboratories of the National Institute of Standards and Technology provide technical leadership and participate in developing the measurement and standards infrastructure critical to U.S. industry, academia, government, and the public.

Goals: The goals of the Laboratories of the National Institute of Standards and Technology are focused on five areas:

Laboratory R&D: Perform research planned and implemented in cooperation with industry that anticipates and addresses the most important measurement and standards needs in a timely fashion.

The National Measurement System: Strengthen the national system of standards, measurement traceability, and conformity assurance.

The International Measurement System: Provide leadership in harmonizing international measurements and standards to facilitate international trade.

Internal Management: Improve the management of technical programs including planning, prioritization, conduct, and delivery of results.

Recognition: Foster broader recognition by stakeholders of the impact of the NIST Laboratories' activities.

Schwartz pointed out that the measurement infrastructure is a complex, interdependent system of technical activities leading to codified or institutionalized practices. The system is composed of measurement methods, basic standards, calibrations, etc., but functions only because of the totality of the components and their interrelation. Many organizations provide input to the components of the measurement infrastructure, but only NIST has responsibility for the system.

We believe that the idea of defining "who we are" is an important initiative but it might be better to add "and who we should become." A collegial effort by the heads of the Laboratories coupled with the Institute leadership can have far-reaching impact if done well.

The Vision statement is sufficiently broad with adequate relevance.

The list of "Values" outlined---excellence, objectivity, creativity, and responsiveness, seems to be a worthy set for the Institute. We might suggest consideration of efficiency and effectiveness as a fifth entry. It does seem appropriate to call for the spare use of resources when they are drawn from the citizenry.

The Mission statement describes a fairly heavy responsibility for the Institute which will be a challenge to execute. We agree that this responsibility might well be the proper role of NIST but it is beyond current practice and will require significant effort and resources to implement. The Institute now works in this area but has not accepted full responsibility for any circumscribed set of functions, due in part to constrained resources. The Committee does not underestimate the difficulty of getting this right but believes it is an important task and one where we might be able to assist by providing outside and collective comment on the work as it progresses. To help in its formulation, the Committee included in its December session a discussion with the Laboratory Council of the possibility of developing a "closed-form" mission statement for the NIST laboratories, rather than a statement of conducting useful activities in an area of total scope beyond its reach. The Committee's definition of a closed form mission is one which is exclusively that of the Institute on behalf of the government, and the size of the effort needed to accomplish that mission is advocated by NIST. We believe we had a useful but inconclusive dialogue which should continue in 1996.

We applaud the formation of the Laboratory Council and believe it has very important long-term value for the Institute. On the other hand, the Council is probably not structurally able to deal with many of the most difficult, cross-laboratory issues. We therefore believe that this strategically important effort cannot be complete until the Director has played an active role in its formulation, resolving enterprise-wide issues, and placing implementation processes in place.

Laboratory Programs

Schwartz continued his presentation with a discussion of the laboratories' goals and progress in five areas:

1) The laboratories perform research planned and implemented in cooperation with industry that anticipates and addresses the most important measurement and standards needs in a timely fashion. Customer needs are determined through strategic planning workshops. Program delivery is focused on strategic industrial sectors, such as with the National Semiconductor Metrology Program. There is increasing emphasis on basic standards in competence programs and in initiative planning.

2) The laboratories facilitate the national system of standards, measurement traceability and conformity assessment. A measurement services quality program has been established in conformity with ISO Guide 25. When needed, accreditation of external testing and calibration laboratories is provided. An unbroken chain of measurement is proved by working directly with secondary standards producers.

3) The laboratories provide leadership in harmonizing international measurements and standards to facilitate international trade. This is achieved by working directly with the International Organization for Standardization (ISO), by working bilaterally with other national standards laboratories, and by training key officials of our trading partners involved in the standards making process to reduce technical barriers to trade.

4) The Laboratories are improving the management and prioritization of technical programs through coordination by the Laboratory Council (Laboratory Directors), the Operations Board (Laboratory Deputy Directors) and the Executive Officers' Board. They have established annual program reviews with a focus on resource allocation.

5) The Laboratories are fostering broader recognition by stakeholders of the impact of the laboratories' activities by working with organized industrial sector groups, by developing a world-wide web page for the laboratories, and by working with the NIST public affairs program.

Schwartz then discussed several examples of how NIST's unique capabilities are an essential part of the measurement infrastructure. These examples display the high value leverage of standards and are useful. There seems to be no short and concise way to do this other than to accumulate lists of examples.

Laboratory Funding

The Committee has said for several years that the fraction of other agency-sponsored research at NIST is too high (1)(1). In order to take control of its own agenda, NIST strategy calls for the use of increased funding to reduce the rate of support of laboratory programs by other Federal agencies, with no increase of laboratory staff. This is to be accomplished by replacing contract research that is not strongly tied to NIST's industrial support mission with more mission-oriented, base-funded research that implements NIST's strategic vision. NIST Director Arati Prabhakar reported to us that significant progress has been made; what was once a 35% dependency on contract support dropped to 22% in Fiscal Year 1995, and would have dropped to well under 20% in the budget proposed by the President for Fiscal Year 1996. However, at the present 1996 NIST budget level, the dependence on other agency funding will remain essentially unchanged from Fiscal Year 1995.

Prabhakar noted that the laboratory programs had a flat direct appropriation in constant dollars until 1991. With significant increases in direct appropriations since that time, priority programs for industry have been increased and core competences are being reinvigorated. Four competence programs were selected during Fiscal Year 1995 for initiation in 1996: near-field optical microscopy for nanometer characterization and manipulation; atomic-scale metrology for nanometer-scale magnetic recording; development and characterization of new biomimetic materials; and *in situ* nanoscale probes of catalysts and catalytic chemistry. The laboratories received budget increases in Fiscal Year 1995 for semiconductor metrology, advanced manufacturing, biotechnology, environmental technologies, advanced materials and processing, information infrastructure, and international trade and standardization. The President's Fiscal Year 1996 budget proposed increases in some of these areas together with new research in health care measurements, construction, and measurements and standards for emerging instrumentation industries. The present Fiscal Year 1996 budget level would not provide for the three new research areas. Nevertheless, we feel that much progress has been made.

INFORMATION TECHNOLOGY LABORATORY

NIST has announced that it plans one major change to its organizational structure (shown in fig. 1), the creation of a new Information Technology Laboratory by combining its existing Computer Systems Laboratory (CSL) and Computing and Applied Mathematics Laboratory (CAML). NIST Director Arati Prabhakar discussed the rationale for the new laboratory. She noted NIST's pervasive measurement role in the industrial revolution. In a similar manner, in the information technology revolution, NIST will focus on high-leverage enabling tools and infrastructural technology. Two of the key issues are interoperability of diverse systems, and scalability of methods as systems grow in size. She noted that CSL currently prepares paper standards primarily for government, and that CAML primarily provides the NIST laboratories with computing and statistical services. These existing laboratories will be combined into a single laboratory focused on industrial needs.

Pending approval of this reorganization, Shukri Wakid was appointed Acting Director of both component laboratories. Wakid reviewed for us the planning for the Information Technology Laboratory. He emphasized that this planning is a work in progress and has not been completed. He noted that information technology is a $590 billion industry, and that jobs in the computer hardware and software component of this industry have tripled in the past ten years. The application of advanced technology to new large information technology markets will require evaluation and test methods, as well as provision of interoperability and security. ITL will work with industry and with the user and academic communities to develop the needed infrastructural technology, using NIST as a test bed. Four areas where ITL can maximize its output have been selected: cross-industry networks; human-machine interfaces; security enabling technologies; and scaling of algorithms, processors, and networks.

In last year's report (1), we pointed out that discussions with several experts involved in information technology and the National Information Infrastructure (NII), led to the conclusion that standards and interoperability are key issues. NIST is uniquely qualified to play a central role in these issues. It was also clear to us that industry does not want the government to set the standards but would welcome NIST in the role of conveyer, facilitator, neutral analyst, and producer of background studies. We further noted that a report of the National Research Council (1) on "Realizing the Information Future" describes a concept called "NII compliance," by which is meant a set of interface standards that determine when a system or subsystem is compatible with the objective of a particular information infrastructure. NII compliance could be used to determine whether a particular fiber/coax video server system is capable of evolving into a system capable of serving the NII. We concluded that it is appropriate for NIST to be the facilitator, keeper, and conformance tester for NII compliance. NIST already has a strong role in conformance testing and is running user groups such as the ISDN users' group, has had success with information standards for security and privacy, and has much to offer in the present environment.

While waiting for approval of the new ITL, significant changes within and between CSL and CAML have been made. The number of Divisions has been reduced from eleven to eight and the number of Groups has been reduced from 48 to 26. Evaluation and testing methods are being emphasized. Work on paper standards has been decreased and the open systems interconnect (OSI) program has been terminated. Wakid discussed the ITL planning process and methods which are being developed to assess the impact of ITL programs.

The Committee applauds NIST's action to rationalize what was clearly an unsatisfactory situation. We believe, however, that much needs to be done to develop the vision and objectives for the ITL and to determine its role in

metrology and standards for this industrial sector. We recognize that this is a challenging task, but it is also an important opportunity. We may be able to help, and plan to make it a part of our 1996 program.

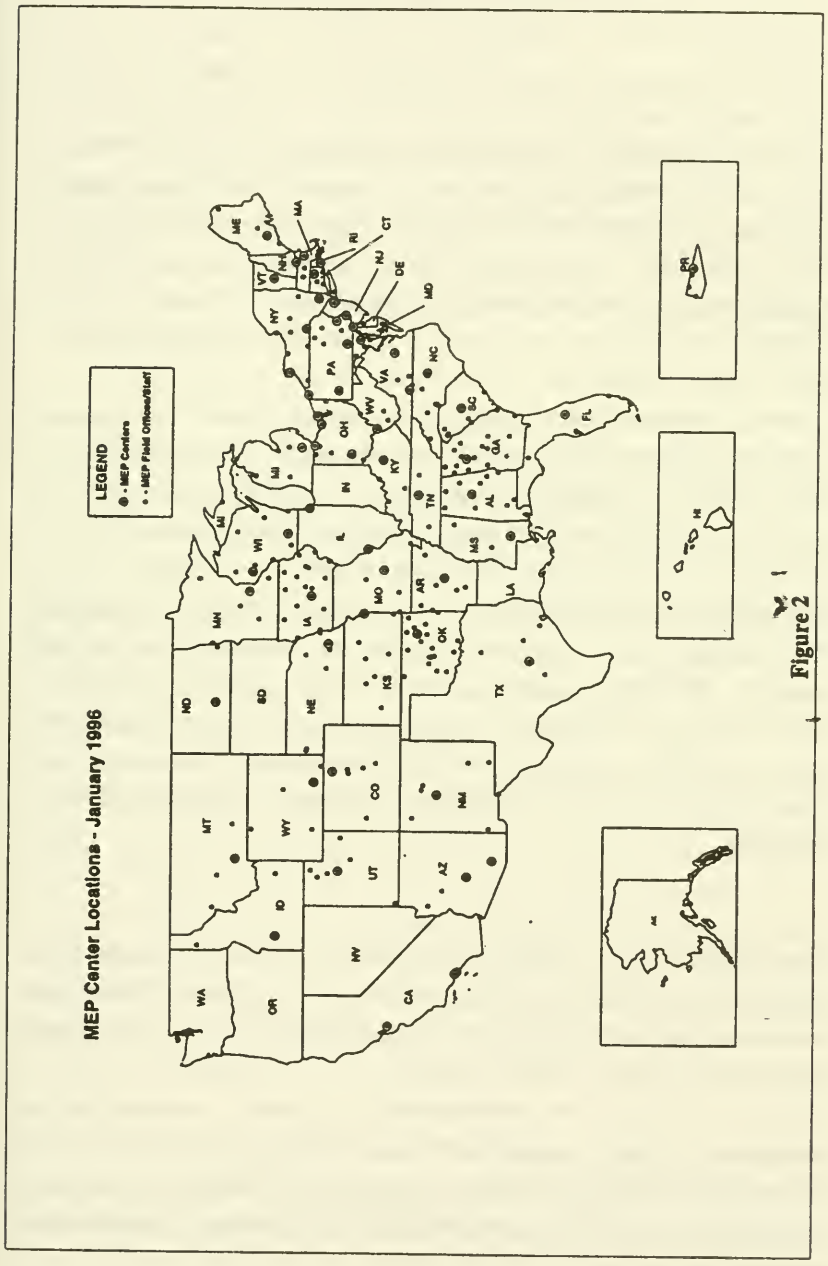
MEP Center Locations - January 1996
LEGEND
● - MEP Centers
▪ - MEP Field Offices/Staff
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Figure 2

BIOTECHNOLOGY PROGRAM

To lead off our planned emphasis on biotechnology, George Whitesides, a member of the Visiting Committee, gave a presentation on the past, present, and future of biotechnology, and discussed some areas of opportunity for NIST. He described biotechnology as the use of biology to solve problems, and discussed four principal phases in the development of biotechnology: 1) antibiotics, food additives and drugs; 2) protein pharmaceuticals including insulin, tissue plasminogen activator, and human growth hormone; 3) technology platforms such as rational drugs and combinatorial methods; and 4) genetics, including DNA analysis and gene therapy. He pointed out that biotechnology is a forefront area of science, is important for health care, provides opportunities for innovation in small companies, and has important implications for public policy. Big changes occurred over the last few years involving smarter investors, failed drugs, health care cost containment, and a shift in biology from an emphasis on proteins to an emphasis on cells and organisms. Whitesides suggested some areas of opportunity for NIST, including the use of information technology for medical cost containment; green manufacturing; medical devices; biophysical and other services for small companies including NMR, crystallography, and analyses; process technology; and sensors.

The Committee also visited the Center for Advanced Research in Biotechnology (CARB). CARB is a joint effort of the Chemical Science and Technology Laboratory (CSTL) of NIST and the University of Maryland Biotechnology Institute (UMBI) focused on the measurements and models needed to advance the understanding of protein structure/function relationships. These measurements and models are important in pharmaceutical development, protein engineering, and interpreting genomic sequence data. The 3437 m^2 (40,000 ft^2) CARB building is located on a campus of the University of Maryland that is 6.4 km (4 mi) from NIST and

close to many local biotechnology companies. CARB is a unique research institution that fosters the collaboration of academic, government and industry scientists. Interactions with industry occur through cooperative research and development agreements, and industry scientists are encouraged to spend time at CARB working on joint research projects. The scientific staff of the Center (about 70 people) includes senior investigators from both UMBI and CSTL, students, postdoctorals, technicians, and visiting scientists. CARB receives funding from NIST, the State of Maryland, federal funding agencies, and industry. NIST provides about one third of the $7.0M annual budget. In addition, scientists at CARB have access to all NIST facilities including central computing.

Research facilities in the CARB building include well-equipped X-ray crystallography and high-field NMR spectroscopy laboratories, laboratories for biophysical studies such as biothermodynamics, spectroscopy, and kinetics, and wet labs for molecular biology and DNA chemistry. The first laboratory visited was the X-ray crystallography laboratory. A multidisciplinary effort was described in which scientists from NIST and the University of Maryland are using molecular biology, structure measurements, thermodynamic measurements, kinetic measurements, and modeling to advance the concept of protein engineering. An industrial collaboration has been established to apply these concepts to improving a detergent enzyme, subtilisin, to eliminate its dependence on calcium ions and to improve its stability. A graphical presentation reviewed the use of molecular modeling and molecular biology to effect the excision of a large number of amino acids in the calcium binding region of the enzyme, followed by a series of amino acid replacements to enhance the stability of the calcium-free protein. The stability enhancements were guided by a novel use of high-resolution X-ray structures to correlate structural temperature factors with dynamical mobility.

The second CARB laboratory visited was the biothermodynamics laboratory. A project was described that seeks to establish a detailed molecular level understanding of protein/protein interactions using structure measurements,

protein engineering, and unique CSTL expertise in biothermodynamic measurements. The use of titration calorimetry to study the energetics of protein/protein associations was presented, using recent applications to antibody-antigen binding as an example. An unexpected result was discussed which implicates interfacial water molecules in the stability of the protein complex. Time did not permit visiting a third laboratory which has developed a new, on-line version of the Biological Macromolecule Crystallization Database (BMCD). The BMCD is now on the World Wide Web, accessible to scientists from around the world who use the data in the development of crystallization strategies for proteins and DNA.

Our visit to CARB was interesting in more than one dimension. The work done there satisfied our intellectual curiosity, although our brief review could not lead to any assessment of quality. The relationship with the University of Maryland is also an interesting one and useful for us to understand. Finally, we discussed the place of this program in the NIST mission without coming to a crisp conclusion. We understand that the research effort at CARB can be viewed as the natural extension to biological systems of the research in the physical sciences and engineering and the production of standard reference data that has been the history of NIST. However, time did not permit us to develop a collective view of the utility of this form of collaboration, how to decide how much is enough, and the role of NIST versus other institutions. We will try to complete these discussions in 1996.

THE ADVANCED TECHNOLOGY PROGRAM

The Advanced Technology Program (ATP) was begun in 1990 in order to invest directly in the nation's economic growth by working with U.S. industry to develop high-risk, enabling technologies that, if successful, can lead to advanced products, manufacturing processes, and services with potentially large economic benefits to the nation. It directly addresses concerns about intensified foreign competition in a global market at a time when there is reduced long-term R&D investment by industry and greatly reduced defense investment in industry. The ATP addresses these concerns by fostering the development of enabling technologies that would not be pursued, would not be pursued in a timely manner, or would not be pursued with the same scope or scale, by private funds alone. Companies prepare the technology development proposals, cost share, and demonstrate a commitment to downstream commercialization. However, the ATP does not fund product development, although a number of "spin-off" products have already resulted from ATP-funded projects (4). The ATP is regarded enthusiastically by U.S. business, is supporting the development of many exciting technologies, and shows promising short-term indicators of success.

During the year, NIST Director Arati Prabhakar provided regular updates on the ATP. We heard a report on one of the focused programs, and took a look at how the ATP is provided with external evaluation and how the results of ATP-funded projects are assessed. We noted that George Uriano, the first Director of the ATP, retired at the beginning of the year and was replaced by Lura Powell. Uriano was instrumental in creating and implementing the ATP.

In her updates, Prabhakar noted that the ATP stimulates U.S. economic growth by promoting the development of high-risk, enabling technologies through programs and projects proposed and cost shared by industry. She

recalled that, in Fiscal Year 1994, 88 new awards were announced from the fifth general ATP competition and from five focused competitions, and that six new focused programs were announced, bringing the total to eleven (see list in Appendix C). During Fiscal Year 1995, one general competition and eleven focused competitions were held, over 700 proposals were evaluated, and 103 awards were announced totaling $413 million. The level of funding in the current Continuing Resolution, if continued for the entire year, would allow continuation of all ATP awards. In our view, the ATP is a sound program, is contributing to the economic health of the nation, and is a wise use of the taxpayers' money.

With the completion of all Fiscal Year 1995 competitions, 280 projects are underway on a cost-shared basis. Industry commitments to these projects amount to more than a billion dollars. Approximately 700 organizations in 42 states and Puerto Rico are involved, including over 100 joint ventures and more than 200 small businesses. Small businesses are involved in over 60% of all ATP awards.

Prabhakar reviewed the process for development of ATP focused programs. This process has substantial involvement of industry. She noted that many additional new ideas for focused programs have been proposed by industry. In a strategy that we strongly supported (1), NIST added focused competitions to its ongoing general competitions in Fiscal Year 1994 in order to accelerate progress in key technology areas that will have the maximum impact on U.S. technological competitiveness.

Prabhakar noted that the Advanced Technology Program has been organized into five offices, Information Technology and Applications, Chemical and Biomedical Technology, Materials and Manufacturing Technology, Electronic and Photonics Technology, and Economic Assessment. She noted that in the area of health care information infrastructure, significant partnering is occurring, emphasis on standards is increasing, and there is much participation

from health care providers; progress in DNA diagnostics is being driven more rapidly; and companies are beginning to see the possibilities for using composite structures in manufacturing.

John Gudas, Director of the ATP Materials and Manufacturing Technology Office, described to us one of the new ATP focused programs, Materials Processing for Heavy Manufacturing, and how it was developed through industry white papers, workshops, and working groups. The overall business goal is to provide U.S. value leadership for products of heavy manufacturing through product differentiation and lower cost. Specific goals are to reduce manufacturing costs for vehicle engines, power trains, and chassis by a factor of two; increase the world-wide market share for U.S. heavy equipment by a factor of two; and increase by 40% the world-wide market share for U.S. stationary power generating equipment. This is to be accomplished by accelerating the introduction of advanced materials into heavy manufacturing and advanced manufacturing into materials processing. The market sectors to be addressed are surface transportation vehicles, heavy equipment (construction, mining, agriculture, oil/gas field), and stationary power generating equipment. The materials scope is limited to metals, metal matrix composites, ceramics, ceramic matrix composites, and coatings. Gudas described the various program concepts which were derived from industry white papers, and outlined how the overall program would be carried out.

We observed in last year's report (1) that companies funded by the ATP assert that they have been helped to accelerate technology development and commercialization by funding high-risk research and development that would not have been done otherwise, or would have been done too late or with too narrow a scope to capture the appropriate market. The ATP has also clearly catalyzed the formation of consortia among companies, and also among companies, university, and government laboratories which were unlikely to have occurred without the ATP. From our contacts it is clear that present

competitive markets pressure companies toward taking a short-term view. However, the ATP encourages companies to take a longer-term outlook. ATP is open to companies of all sizes – from start-ups to major corporations. About half of the awards to date have been made to small businesses, reflecting the entrepreneurial strength in these firms. Even in the case of large companies, the ATP process stimulates entrepreneurial efforts within these companies.

Evaluation of the ATP Program

Brian Belanger, Deputy Director of the ATP, discussed with us the ways in which the ATP is provided with external evaluation. He noted that there are three key evaluation issues: 1) Is ATP accomplishing its mission of stimulating economic growth via cost-sharing of high-risk industrial R&D? He noted that rigorous impact assessment is in place, and that extensive data is being gathered and evaluated. 2) Is ATP's focused program development process optimal? He noted that program planning with industry involves white papers, workshops, industry studies, and working groups. 3) Could the management, administration, and policies of ATP be improved? He noted that ATP tracks key performance measures, for example, the time to process awards, and that many changes have been made to make ATP more user-friendly. Belanger discussed the many external mechanisms for evaluation that are applied to the ATP: the NIST Visiting Committee; Office of Management and Budget (OMB) and Congressional scrutiny; program planning with industry; customer feedback; meetings with companies, trade associations, and unions; third-party surveys and studies; DOC Inspector General and General Accounting Office audits; and the involvement of prestigious economists to develop, apply, and critique the ATP impact assessment methodology.

Assessment of ATP Results

Rosalie Ruegg gave us an update on ATP and its assessments of results. Since the ATP began in 1990, there have been 22 competitions, with 2,210 applications and 280 awards. Of the 178 awards to single businesses, over half have been to small businesses. Of the 102 awards to joint ventures, over one quarter have been led by small businesses. Of the total funds committed, over one half are provided by industry.

Ruegg gave an overview of how ATP's evaluation plan is structured to fit the multiple dimensions of the program – increasing the science and technology knowledge base, relying on companies to commercialize the technology, and promoting widespread use of the resulting enabling technologies – as well as to fit the longer time frame over which its impacts will be useful. She described several on-going studies which are attempting to measure how ATP funding leverages private resources to produce technology-driven public benefits. The new studies will broaden the range of techniques used and the benefits studied, including an attempt to measure public benefits beyond those to the companies directly using the technology. An economic evaluation workshop was held on September 29, 1995 to discuss the various techniques that will be used.

Ruegg pointed out that less than 10% of all ATP projects to date have been completed. Because most of the economic benefits are expected to be realized over several years after completion of the project, there is not much data yet on total benefits. However, ATP is building a comprehensive database on its projects and the applications of the technologies. Several projects are producing early benefits. For example, initial commercialization of an ion implantation process is underway, with a licensing agreement for production of ion implanters. A project to improve the dimensional accuracy of auto body components is projected to result in approximately $150 per car cost savings

in production. It is estimated that there will be a lifetime savings of as much as $400 per car in maintenance and repair. In addition, important employment and GDP effects are expected to result as higher-quality automobiles lead to increased U.S. market share. Further, the technology is expected to be adapted to other manufacturing sectors where additional benefits are expected in the future. Many companies report significant short-term results including expansion of high-risk, enabling R&D, acceleration of the R&D cycle, reduction in time to market, new R&D business alliances, and early commercialization progress. A NIST report (4) gives many examples of the ways in which ATP awards are making a real difference in industry.

Our response to the presentations and discussions on extramural program evaluations and assessments of results for the ATP will be given in a following section of this report, "Evaluation of the ATP and MEP."

THE MANUFACTURING EXTENSION PARTNERSHIP

The Manufacturing Extension Partnership (MEP) assists the nation's smaller manufacturers through locally-run Manufacturing Extension Centers. These Centers help with the adoption of modern manufacturing processes, business practices, and appropriate technologies and techniques. The Centers are industry driven, are selected by a rigorous, merit-based process, and are cost-shared with state and local governments.

During the year, we received regular updates on the MEP from NIST Director Arati Prabhakar. We also took a look at how the MEP is provided with external evaluation and how the results of MEP-funded projects are assessed.

Prabhakar reviewed the status of the MEP, pointing out that with the announcement of 18 new awards in 1995 it has now grown to be a truly national manufacturing support program with 60 Manufacturing Extension Center awards. Together with over 240 field offices in 42 states, this national system now provides access to manufacturing extension services for nearly four-fifths of the country's small manufacturers. A list of the Center awards is contained in Appendix C, and the locations of the Centers and field offices are shown on Figure 2. NIST provides services and tools to the Centers to enhance their capabilities and to improve the delivery of services to small manufacturers. This includes information management, training, environment, workforce development, and evaluation and benchmarking. We believe that the recent emphasis on workforce development is noteworthy. To facilitate communication among the components of this program, quarterly meetings of the Center Directors are held, as well as regional meetings of local Center staff, NIST-sponsored workshops, and an annual conference with about 700 to 800 field engineers in attendance.

Of the 60 Center awards, 36 were funded by the Defense Department's Technology Reinvestment Program (TRP) in Fiscal Years 1994 and 1995 and managed by MEP. It is expected that 20 of these Centers will be converted to NIST funding in Fiscal Year 1996. The remaining Centers are planned to be converted to NIST funding in Fiscal Year 1997, pending a satisfactory review. The Centers provide valuable support and assistance to thousands of small companies. Client evaluation surveys show a large return on the MEP investment. MEP is working to integrate the centers through electronic linkages and strategic partnerships with other government and private organizations. We strongly support the MEP plan.

Evaluation of MEP Program

Kevin Carr, Director of the MEP, discussed with us the program evaluation strategies for the MEP. After briefly describing the MEP and its organizational relationships, he emphasized that MEP activities are short term and project focused, but have long-term impacts as client companies become stronger. He then described an ongoing evaluation planning process which started with nine external white papers. These papers have been reviewed and an evaluation plan is being drafted which will be reviewed by a "kitchen cabinet" of several external reviewers. The resulting evaluation plan will be reviewed by a large number of people from the Manufacturing Extension Centers (MECs), from state government, from universities, and from other government agencies. The aim is to define, measure, analyze, and report on center-specific and national program results, to assess and enhance the quality of program management, and to interpret and verify the MEP national mission. Carr also discussed a recent Memorandum of Understanding for cooperation between MEP and the Science and Technology Council of the States which is a working group affiliated with the National Governor's Association. The agreement was signed by 27 states, Puerto Rico, and the

Virgin Islands.

Assessment of MEP Results

Ruth Haines, MEP Associate Director for National Programs, provided us with an overview of the MEP, and discussed the MEP economic evaluation plan and evaluation programs which are being carried out. The MEP presently consists of 60 Manufacturing Extension Centers which provide access to services for about four-fifths of the small manufacturers in the United States. Haines discussed the types of activities and client interactions at these Centers. She described a GAO study (1) of a broad range of manufacturing extension programs (which does not solely address the NIST MEP) which gathered manufacturers' views on the impact of manufacturing extension services on their business performance. About 73% of the respondents viewed manufacturing extension services as producing a positive impact. Of those respondents who had made a financial investment, about 86% viewed manufacturing extension services as producing a positive impact. No companies making financial investments reported a negative impact.

The MEP has a well-developed evaluation infrastructure. White papers, review teams, and a national conference contribute to the strategic plan. Other activities include data collection, Center working groups, evaluation research, education and training, periodic reviews of the Centers, and national advisory panels. Past practice involved asking clients to estimate project impact. For 381 projects surveyed, an average impact of about $365,000 was reported An improved methodology has been developed using a third-party survey firm. It includes a new reporting format to facilitate analyses and to collect information on project costs. Surveys are carried out six to eight months after project completion. One of the results of a pilot of the new survey is that the client response rate increased from 25% to 74%. The new methodology will

be expanded system-wide, with results expected in spring 1996.

A special study was carried out on one of the MEP centers. Of the projects studied, the ratio of net returns to net investment due to industrial modernization varied from 1.2 to 2.7. There was also a high leveraging of private investment, with the ratio of private to public investment varying from 2.9 to 13.3. Other studies are planned which would use Census Bureau plant-level databases to compare client to non-client performance over time.

The MEP has a number of ongoing activities that track or estimate impacts on the performance of small manufacturers from engagements with extension centers. In addition, the MEP is initiating further studies, with varying time horizons, that are intended to supplement the current data and track impacts over longer terms. Preliminary results of one center's Client Progress Survey show, for example: sales, +13%; scrap rate, -29%; exports, +47%; employment, +6%; and computer usage, +46%. We believe that these data, together with other data cited above, are evidence of the value of the MEP. In addition, a NIST report (4) discusses six specific examples of how the manufacturing extension centers are helping U.S. industry to improve productivity, implement process controls, and develop improved products.

Our response to the presentations and discussions on extramural program evaluations and assessments of results for the MEP will be given in the following section of this report, "Evaluation of the ATP and MEP."

EVALUATIONS OF ATP AND MEP

External Evaluations

In response to the presentations and discussions on extramural program evaluations of the ATP and MEP (see the previous two sections of this report), the committee came to the following conclusions and recommendations:

With respect to the ATP and MEP, the internal process of selection and assessment of program has been given a great deal of thought and management energy and the committee has no recommendations for change in this internal activity. However, we believe that there is a need for a third party process involving outside scrutiny much as the NRC Board on Assessment performs for the laboratory programs.We examined alternative methods for achieving this objective including an expanded role for the VCAT. Our recommendation is that NIST ask the NRC to expand the role and character of the Board on Assessment to perform this function for the ATP and MEP. We recognize that the personnel make-up of the panels which would provide for these reviews must be different from each other and substantially different from the current Board on Assessment panels evaluating the laboratories. The Executive Committee of the Board should also be modified to reflect the skills and judgment appropriate to span both the intramural and extramural programs.

Assessment of Program Results

The program evaluations which we requested on the MEP and ATP served the purpose we envisioned. They demonstrated the kinds of efforts which are

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underway and provided the Committee with a basis for making some of their own assessments. Neither of the approaches presented are all that satisfying for those who are searching for a relatively comprehensive approach. Others are not surprised to find a substantial degree of incompleteness in what is, in the end, a highly subjective phenomenon. The committee has in its membership various shades of position and has not chosen to give any clear reaction to the sessions in this report.

The Committee was clearly more comfortable with the status of the MEP evaluation process. The ATP has gathered a large amount of data, and has had carried out several studies of the aggregate rate of economic return (usually called "social rate of return") which have shown very high rates of return. New studies will attempt to measure public benefits beyond those to the companies directly using the technology. The Committee believes that the major emphasis should be on improving the tangible measures in the studies of aggregate rate of economic return and continuing to collect data which can be available for ex post research.

THE MALCOLM BALDRIGE NATIONAL QUALITY AWARD PROGRAM

The Malcolm Baldrige National Quality Award has increased enormously the understanding and application of quality principles in this country. Since 1988, 24 companies have won the Baldrige Award. Over one million copies of the award criteria have been distributed. An annual conference is held at which award winners present details of their quality improvement strategies and results. Award winners have shared information with hundreds of thousands of companies, educational institutions, government agencies, health care agencies, and others. The award has thus had an impact which reaches far beyond the award winners.

During the year, NIST Director Arati Prabhakar provided regular updates on the Quality Program. We also took a look at the evaluation of the Quality Program and at the pilot programs for health care and education.

Prabhakar noted that there has been a significant rewrite of the criteria (1) for the Malcolm Baldrige National Quality Award. The revised criteria are more directed toward the requirements of business strategy and competitiveness, are more future oriented, and are more focused and aligned, with a 40% reduction in the numbers of areas to be addressed by applicants. Pilot programs in education and health care have been held (see report below).

Two Baldrige National Quality Awards were announced last fall. The Presidential ceremony recognizing these awards may be held early in 1996.

Evaluation of the Baldrige Quality Program

Curt Reimann (who retired as Director of the Office of Quality Programs in December 1995) discussed with us the operation of the Malcolm Baldrige National Quality Award Program and the Board of Overseers which was established to evaluate the Award Program and to advise the Director of NIST and the Secretary of Commerce on the conduct and improvement of the Award Program. This Board is patterned after the NIST Visiting Committee and Board on Assessment system. The Board of Overseers meets twice annually, and receives written reports from NIST and from the Panel of Judges. The Board provides written and oral reports to the Secretary of Commerce and the NIST Director. The details of the Award Program are evaluated by the Panel of Judges, the body involved directly in the process, which meets four times annually and has an annual joint meeting with the Board of Overseers. Reimann emphasized the fact that many improvements to the Award Program have resulted from recommendations from the Panel of Judges and from the Board of Overseers.

The current procedure for selecting Baldrige Award winners and assessing the program itself involves a broad selection of outside participants. We judge this to be an excellent process and make no recommendations for change.

Pilot Programs in Health Care and Education

Harry Hertz (now Director of the Office of Quality Programs) described the development and organization of the Malcolm Baldrige National Quality Award Program, and its possible extension from business awards to awards in the areas of education and health care. He explained that NIST is a logical place for such new awards because of strong business interest in these areas

and because the lessons learned from the business awards are relevant and transferrable to education and health care awards. Further advantages are a common process and overseers, a common standard of excellence, cross training of examiners, and NIST's reputation for objectivity, consensus building, and fairness. Studies for possible awards in education and health care were initiated in 1992, and involved numerous organizations in each sector. A pre-pilot program was carried out in 1994. Hertz discussed the pilot criteria which have been developed and published for both education (1) and health care (1), and the pilot programs which were planned and subsequently carried out. The pilot programs were broadly advertised, with applications due by May 10, 1995. There was an enormous response. Over 20,000 copies of the criteria were requested, and 46 health care and 19 education applications submitted. No awards were given in the pilot phase, but feedback will be given to applicants, and the results will guide the future development of the program.

The Baldrige Awards program provided a mechanism that recognized industry for focusing effort and attention on raising standards for quality, at a time when raising quality was a necessity for becoming or remaining globally competitive. This program has widespread utility in industry, both in raising consciousness, and in providing standards for measuring quality. The pilot programs in health care and education have received a very positive response. The Committee feels that it would be worthwhile considering establishing awards modeled on the Baldrige program to recognize accomplishment and innovation in these areas. We believe that this could ultimately benefit the manufacturing and service areas which are now the focus of the Baldrige Awards, in helping them to meet pressing needs for a better educated and trained work force, and to provide cost-effective health care to their workers.

The Council on Competitiveness, believing that qualtity is the key to competitiveness, undertook a study to explore mechanisms for furthering understanding of quality management in the United States. The product of this

study is a report (1) entitiled "Building on Baldrige: American Quality for the 21st Century." The Council found that, "The Baldrige Award Program, having galvanized U.S. quality efforts, is now positioned to become the vehicle to stimulate and coordinate efforts to expand quality as a national priority." The report contains five recommendations to expand the reach and impact of the Program, including changing the Award Program to a Baldrige National Quality Center.

NIST's pilot quality award programs in health care and education will be discontinued in 1996 because federal funding to support them is not included in the proposed Congressional appropriation. NIST will continue to work with the health care and education communities to establish a base of long-term, private sector funding similar to the more than $10 million raised by a private foundation for the business awards.

TECHNOLOGY AND QUALITY OF LIFE

Howard Samuel led a Committee discussion of a potential role for the Committee in developing a better understanding of the relationship between technology and quality of life in a modern society. With encouragement from the NIST Director, the Committee agreed to help organize and participate in a conference which would bring experts together on this topic. Samuel played a key role in organizing the conference, cosponsored by the Council on Competitiveness and NIST, entitled *The Global Growth of Technology: Is America Prepared*? It was co-chaired by Arati Prabhakar, Director of the National Institute of Standards and Technology, and by John Yochelson, President of the Council on Competitiveness. The one-day conference consisted of five sessions with six speakers:

- The Impact of Technology on the U.S. Ability to Compete

  Robert J. Hermann – Senior Vice President, Science and Technology, United Technologies; Chairman, Visiting Committee, NIST

- The Implications of Technology Growth for Industry

  Thomas Everhart – President, California Institute of Technology

- The Implications of Technology Growth for Workers

  Gary Burtless – Senior Fellow, Brookings Institution

- Implications of Technology Growth on the Quality of Life

  Diana MacArthur - Chair, CEO, and Co-founder, Dynamac Corporation; member, President's Committee of Advisors for Science and Technology

  Rita Colwell - President, University of Maryland Biotechnology Institute; President, American Association for the Advancement of Science

- Technology and Government Policy: What Level is Appropriate?

  Robert Galvin - Chairman, Executive Committee, Motorola, Inc.

The Conference was held on December 7, 1995 at NIST, immediately following the December Committee meeting. Committee Chairman Robert Hermann was one of the six speakers, and Committee members Kittler, Saldich, and Westwood were among the 46 participants. We believe that it was a useful beginning in addressing a difficult topic. A report on the Conference is in preparation by the cosponsors.

COMMUNICATIONS

Mat Heyman discussed for us NIST's communications strategies. He pointed out that NIST has gone through a series of changes over the past several years, expanding its portfolio of activities to promote U.S. economic growth. Communications have been increasingly critical for NIST, both in promoting that mission expansion and in ensuring that NIST achieves its goals in delivering value to industry and the taxpayers. NIST's key audiences are industry, Congress, and Administration policy makers. Other important audiences are the news media, universities, state and local organizations, and other government agencies. The key elements of NIST's communications strategy are: 1) receive as well as transmit; 2) set priorities and use multiple vehicles; 3) capitalize on NIST's strengths; 4) never oversell or overpromise; and 5) always assume that the job will change. The key components of NIST's message are: 1) NIST carries out jobs for public good which neither industry nor government can do alone; 2) industry drives NIST's priorities and is NIST's partner; and 3) NIST delivers results that have impact. Heyman emphasized the fact that NIST's personal contacts with Congress, Administration officials, business leaders, and trade and professional associations have increased significantly during the past year.

The discussion regarding NIST communications strategy and practice was useful. The Institute has an active program aimed at an important set of audiences. There are always judgmental differences possible about how much is enough and about audience targeting but the Committee found no reasons for proposing changes in the current program.

TOPICS FOR STUDY - 1996

In 1996 we will focus on what we believe are critical issues in NIST's major program areas. Many of these issues arose from our discussions with NIST senior management this year. We will continue to work with the NIST laboratory management to develop a "closed-end" mission statement. We will revisit the strategic plans of the new Information Technology Laboratory to view how ITL defines and prioritizes its technical programs in support of a large and diverse industry. We continue to believe that NIST's international standards activities are critical to U.S. industrial competitiveness and will be interested in reviewing a plan for a staged increase in this activity. In the Advanced Technology Program and the Manufacturing Extension Partnership, we will continue to focus on how to assess the value of the results from these programs. We will continue the examination of NIST's biotechnology programs which we began in 1995. We also want to take a look at the methodology for prioritizing programs. We will continue to monitor the Malcolm Baldrige National Quality Award Program and to assess progress on NIST's Capital Improvements Facilities Program as it enters the construction phase. The presentations by Committee members to NIST management, initiated in 1995 with three such presentations, are viewed as useful and will be continued in 1996.

APPENDIX A
Summary of Visiting Committee on Advanced Technology Activities, 1995

Reports and Statements*

- *1994 Annual Report of the Visiting Committee on Advanced Technology (January 1995)*

* Copies of all reports are available from the Executive Director of the Visiting Committee on Advanced Technology, National Institute of Standards and Technology, Gaithersburg, MD 20899.

Special Meetings

- Meeting of 1994 Visiting Committee Chairman Robert W. Lucky with Secretary of Commerce Ronald H. Brown and other Department of Commerce officials on March 8, 1995, to discuss the Visiting Committee's 1994 Annual Report and NIST issues.

Congressional Testimony

- Testimony submitted for the record, Hearing on the Fiscal Year 1996 TA/NIST Budget Authorization, Subcommittee on Science, House Committee on Science, March 23, 1995, by Robert W. Lucky, 1994 Visiting Committee Chairman. The record of the hearing also included the full text of the Visiting Committee's 1994 Annual Report.

- Testimony at Hearing on the NIST laboratory programs, House Committee on Science, September 12, 1995, by Robert J. Hermann, Visiting Committee Chairman.

Quarterly Business Meetings

Meeting Dates

March 14-15 September 12-13

June 6-7 (Boulder) December 5-6

Principal Meeting Topics

- NIST Program Update (3/95, 6/95, 9/95, 12/95)
- NIST Budget Issues (3/95, 6/95, 9/95, 12/95)
- NIST Laboratory Programs (9/95, 12/95)
- The Advanced Technology Program (3/95, 6/95, 9/95)
- The Manufacturing Extension Partnership (6/95, 9/95)
- The Malcolm Baldrige National Quality Award Program (3/95, 6/95)

- [ ] Standards and International Trade (6/95, 9/95)

- [ ] Capital Improvements Facilities Program (12/95)

- [ ] Information Technology Laboratory (12/95)

- [ ] Presentations by VCAT members (6/95, 9/95, 12/95)

Laboratory Tours and Presentations

- [ ] Molecular Measuring Machine

- [ ] Laser Ionization Flux Monitor for Semiconductor Films

- [ ] Bose-Einstein Condensation in Rubidium Atoms

- [ ] Scanning Capacitance Microscopy

- [ ] Center for Advanced Research in Biotechnology

APPENDIX B
Advanced Technology Focused Programs

The first five ATP focused programs, announced in April 1994, are now:

- *Tools for DNA Diagnostics* - a five-year, $145 million program to develop compact, low-cost, automated DNA analysis technologies and equipment to enable fast, inexpensive detection and diagnosis of human, animal, and plant diseases.

- *Information Infrastructure for Healthcare* - a five-year, $185 million program to develop critical information infrastructure technologies to enable enhanced, more fully integrated medical information systems across the healthcare industry, greatly reducing costs and errors in handling medical information.

- *Manufacturing Composite Structures* - a five-year, $160 million program to reduce the high initial costs of manufacturing advanced composite materials, traditionally found only in military and sports applications, to enable the use of these strong, lightweight, durable materials in large-scale commercial applications such as bridges and automobiles.

- *Component-Based Software* - a five-year, $150 million program to develop the tools and infrastructure needed to enable the automated composition of software components and to enable a market in those components.

- *Technologies for the Integration of Manufacturing Applications* - a

five-year, $105 million program to develop a flexible, software-based framework needed to promote greater manufacturability, productivity, and product variety in discrete manufacturing – allowing U.S. firms to more easily scale up and reconfigure their manufacturing operations. This program expands upon and supersedes the Computer-Integrated Manufacturing for Electronics focused program.

Six additional focused programs, announced In December 1994, are now:

- *Motor Vehicle Manufacturing Technology* – a five-year, $185 million program to foster innovations in manufacturing technologies that can strengthen capabilities and lead to dramatic advances along the entire automotive production chain, including more versatile equipment, better control and integration of processes, and greater operational flexibility at all levels. Automotive suppliers are expected to be key partners and players in this program.

- *Catalysis and Biocatalysis Technologies* – a five-year, $160 million program to develop the tools, abilities, and theoretical insight to identify, design, and implement new catalysts and processes of major economic importance to chemical producers and users. Breakthroughs in these core technologies can significantly lower operating costs associated with energy, raw materials, and environmental improvement; reduce capital costs for investment in new technologies; speed discovery of competitive and environmentally superior process chemistries; and increase use of design/modeling tools for customizing processes to meet consumer demands.

- *Materials Processing for Heavy Manufacturing* – a five-year, $145 million program to develop and demonstrate innovative materials

processing technologies that will help U.S. heavy manufacturing companies make longer lasting, more reliable, and more efficient products. Truck engines that need overhauls only after 1.6 million kilometers (1 million miles), drive trains that require only half as much maintenance and repair, and a 2% increase in power-generation efficiency are examples of advances that could result from research in this focused area.

- *Digital Data Storage* – a five-year, $125 million program will concentrate on six technical objectives: increase tape and disk storage density, develop better performing magnetic recording heads, develop new lubricants and surface finishes, develop more reliable tracking devices, improve signal-processing electronics, and significantly advance the state-of-the-art in data storage and retrieval software. By assisting industry to exploit the revolution in digital storage, the program will help American companies to expand digital storage markets and market share dramatically.

- *Digital Video in Information Networks* – a five-year $120 million program to help develop interoperable digital video capabilities for emerging information networks through techniques for encoding, converting, and transcribing video data into the various forms required by the network. The program will help U.S. firms to take commercial advantage of the information network to allow any video-based information product to travel via wire, optical fiber, satellite, or broadcast seamlessly into regular TVS and other information appliances.

- *Vapor Compression Refrigeration Technology* – a five-year, $50 million program to develop more efficient, quiet, and compact air-

conditioning and refrigeration systems with the lowest achievable environmental impact. The projects selected will focus on improving the vapor compression cycle, the principle of operation for most current cooling equipment. The overall technical goals are to increase system efficiency, reduce noise levels, and reduce refrigeration components' sizes – each by 25% – and to design and manufacture a system in which no refrigerant leaks.

APPENDIX C
Manufacturing Extension Center Awards

Listed alphabetically by lead state.

Alabama Technology Network

Industry Network Corporation (INC) (Arizona)

Industry Network Corporation (INC) (Arizona Regional Office)

Arkansas Manufacturing Extension Network

California Manufacturing Technology Center (CMTC)

Northern California Manufacturing Center

Pollution Prevention Center (California)

Mid-America Manufacturing Technology Center (MAMTC) (Colorado)

Connecticut State Technology Extension Program (CONN/STEP)

Delaware Manufacturing Alliance

Florida Manufacturing Extension Partnership

Georgia Manufacturing Extension Alliance

Idaho Manufacturing Alliance

Chicago Manufacturing Center

Iowa Manufacturing Technology Center (Iowa MTC)

Mid-America Manufacturing Technology Center (MAMTC) (Kansas)

Kentucky Technology Service

Maine Manufacturing Extension Partnership

Central Maine Manufacturing Extension Center

Maryland Manufacturing Modernization Network

Massachusetts Manufacturing Partnership (MMP)

Michigan Manufacturing Technology Center (MMTC)

Minnesota Manufacturing Technology Center (MnMTC)

Mississippi Polymer Institute and Pilot Manufacturing Extension Center

Mid-America Manufacturing Technology Center (MAMTC) (Missouri)

Mid-America Manufacturing Technology Center Southern Missouri (Rolla)

Montana Manufacturing Extension Center

Nebraska Industrial Competitiveness Service (NICS)

New Hampshire Regional Manufacturing Technology Center

New Jersey Manufacturing Extension Partnership

Industry Network Corporation (New Mexico)

Hudson Valley Technology Development Center (New York)

University Industry Public Partnership for Economic Growth (UniPEG) (New

York)

Industrial Technology Assistance Corporation (New York)

Western New York Technology Development Center

North Carolina Manufacturing Extension Partnership

North Dakota Manufacturing Extension Center

Great Lakes Manufacturing Technology Center (GLMTC) (Ohio)

Northeast Ohio Manufacturing Technology Center

Miami Valley Manufacturing Extension Center (Ohio)

Lake Erie Manufacturing Extension Partnership (Ohio)

Oklahoma Alliance for Manufacturing Extension

North/East Pennsylvania Manufacturing Extension Partnership

VCAT

Delaware Valley Industrial Resource Center (DVIRC) (Pennsylvania)

Manufacturing Technology Industrial Resource Center (MANTEC) (Pennsylvania)

Southwestern Pennsylvania Manufacturing Extension Partnership

Plastics Technology Deployment Center (Pennsylvania)

Puerto Rico Manufacturing Extension, Inc

Rhode Island Manufacturing Extension Service

Southeast Manufacturing Technology Center (SMTC) (South Carolina)

Tennessee Manufacturing Extension Partnership

Texas Manufacturing Assistance Center

Utah Manufacturing Extension Partnership

Vermont Manufacturing Extension Center

Virginia Alliance for Manufacturing Competitiveness

A.L. Philpott Manufacturing Center (Virginia)

West Virginia Partnership for Industrial Modernization

Northwest Wisconsin Manufacturing Outreach Center

Wisconsin Manufacturing Extension Partnership

Mid-America Manufacturing Technology Center Wyoming Regional Office

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